Boston Elevated Railway Company:
Elevated Mainline Structure
(Metropolitan Bay Transportation
Authority, Orange Line)
Boston
Suffolk County
Massachusetts

HAER No. MA-14

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Department of the Interior
Washington, D.C. 20013-7127

HAER
MASS.
13-BOST,
127-

TRANSMITTAL FORM

Date: July, 1986

Project Name: Boston Elevated Railway Company: Mainline Elevated Structure (MBTA - Orange Line)

Staff Member: Eric N. Delony, Principal Architect Phone: 202-343-9629

Collection: HABS ___ HAER X HABSI ___ OAHPI ___ OTHER ___

State(s): Massachusetts

County(s): Suffolk

City(s) or Vicinity(s): Boston

Neighborhood or District: South End, Roxbury and Jamaica Plain

Site(s) and/or Structure(s): An Elevated Rapid Transit Railroad structure with Six Stations

Addendum: No X ; Yes ___; To: ___

Sponsors:

U.S. Department of Transportation, Urban Mass Transit Administration address and contact person unknown

Massachusetts Bay Transporation Authority, Southwest Corridor Project. 500 Arborway, Boston, Mass. Daniel L. Ocasio, Director of Design & Development, Southwest Corridor Project.
Kaiser Engineers/Fay Spofford & Thorndike (sub-consultants to MBTA) Six St. James Avenue, Boston, MA 02116, Charles D. Shaker, Manager, Urban Desgin

SHPO: Ms. Valerie Talmadge: Executive Director
Massachusetts Historical Commission
80 Boylston Street
Boston, MA 02116

Regional Directors: James W. Coleman, Jr., Regional Director
Mid-Atlantic Office, National Park Service
143 South 3rd, Street, Philadelphia, PA 19106

Comments:

This report was compiled to serve as a mitigatory documentation of the structure to comply with the requirements of the Memorandum of Agreement, signed February 1978 by the Advisory Council on Historic Preservation; the Massachusetts Bay Transportation Authority (MBTA); Boston Landmarks Commission; Urban Mass Transportation Administration, and the Massachusetts Historic Preservation Officer. The preparation of this report has been financed in part through a grant from the U.S. Department of Transportation Administration, under the Urban Mass Transportation Act of 1965, as amended.

United States Department of the Interior
National Park Service
Washington, D.C. 2024D

HISTORIC AMERICAN ENGINEERING RECORD
SITE DATA FORM

STATE
Massachusetts

COUNTY
Suffolk

TOWN OR VICINTY
Boston

HISTORIC NAME
Boston Elevated Railway Company: Elevated Mainline Structure

HAER NO.
MA-14

SECONOARY OR COMMON NAMES
MBTA - Orange Line

COMPLETE AODRESS (DESCRIBE LOCATION FOR RURAL AREAS)
Washington Street, Boston, Mass. from Oover Street to Forest Hills and through the South End, Roxbury and Jamaica Plain.

DATE OF CONSTRUCTION   ENGINEER, BUILDER, OR FABRICATOR
Engineering Department - former Boston Elevated Railway Company
George A. Kimball - Chief Engineer   1898-1901 & 19D6-1909

SIGNIFICANCE (TECHNOLOGICAL ANO HISTORICAL, INCLUOE ORIGINAL USE)
Elevated structure is the last remaining portion of a formerly extensive elevated rapid transit system built at the turn of the century in Boston.

STYLE (IF APPROPRIATE)
Elevated structure to support rapid transit railway system (electric)

MATERIAL OF CONSTRUCTION (INCLUDE STRUCTURAL SYSTEMS)
Tracks spiked to wood ties bolted to steel trusses (longitudinal) which are framed into transverse bents which in turn frame into two columns supported by concrete foundations on solid material under street.

SHAPE AND DIMENSIONS (SKETCHED FLOOR PLANS ON SEPARATE PAGES ARE ACCEPTABLE)
See reproductions of original drawings.

EXTERIOR FEATURES OF NOTE
Three variants of a then common elevated structure constructed of sections built up of riveted assemblages of rolled structural steel. Stations were designed in several styles (Beaux Art fashion) to adapt to the steel elevated structure.

INTERIOR FEATURES OF NOTE (OESCRIBE MECHANICAL SYSTEMS, MACHINERY OR EQUIPMENT)
Trains were from four to eight cars long powered by electricity, gathered from a third rail and run by the "multiple unit" system of propulsion.

MAJOR ALTERATIONS AND ADDITIONS WITH OATES
Oudley Station altered in 1908 and in 1948. Forest Hills extension opened for use in 1909.

PRESENT CONDITION AND USE
Structure has lost 30% of its metal through corrosion but is presently structurally adequate for regular rapid train service.

OTHER INFORMATION AS APPROPRIAE
The structure is currently in use but is slated for demolition in 1987, when it will be supplanted by a new relocated Organe Line.

SOURCES OF INFORMATION (INCLUDING LISTING ON NATIONAL REGISTER, PROFESSIONAL ENGINEERING SOCIETY LANDMARK OESIGNATIONS, ETC.)
Information not available

COMPILER, AFFILIATION
Cynthia R. Zaitzevsky, Consultant in Architectural History

DATE
July, 1986

HISTORIC AMERICAN ENGINEERING RECORD

BOSTON ELEVATED RAILWAY COMPANY - ELEVATED MAINLINE STRUCTURE (MBTA - ORANGE LINE)

HAER NO. MA-14

LOCATION: The extant (1986) portion of the original elevated Mainline of the former Boston Elevated Railway Company (BERy) is located on Washington Street, in the South End, Roxbury and Jamaica Plain districts of Boston, Mass. and runs between the South Portal of the Washington Street tunnel and the Forest Hills Station, repair shops, and storage yards (Bents #1215 to #772). The original Mainline of the Boston Elevated Railway ran from Sullivan Square, Charlestown to Dudley Street, Roxbury and was later extended to the Forest Hills Station. The remaining structure consists of six stations. Bent numbers are indexed on plans in the files of the Massachusetts Bay Transportation Authority (MBTA) Engineering Department. Grid Coordinates refer to the Boston South Quad.

	STATIONS	GRID COORDINATES
1.)	Dover Street (Bents #1174-1181)	19.0329780E.4689820N
2.)	Northampton Street (Bents #1093-1098)	19.0328880E.4689000N
3.)	Dudley Street (Bents #1024-1040)	19.0328260E.4688250N
4.)	Egleston (Bents #908-915)	19.0328030E.4686760N
5.)	Green Street (Bents #857-864)	19.0326500E.4686070N
6.)	Forest Hills (Bents 783-789)	19.0325780E.4685100N

DESCRIPTION: The Mainline of the BERy at one time consisted of six sections which traversed the congested areas of Boston and Charlestown to Roxbury and Jamaica Plain. For convenience these sections will be categorized alphabetically, according to their original locations, and hereafter will be referred to by Section letter. The main body of this report concerns Section F. The sections are indexed on plans of the former BERy, MTA and the current MBTA. These plans have been included in this study as Fig. No. HD-1, HD-2, HD-3, HD-4, and HD-5.

* * * *

This report with the accompanying illustrations was compiled to serve as a mitigatory documentation of this structure in order to comply with the requirements of the Memorandum of Agreement, signed February 1978 by the Advisory Council on Historic Preservation; Urban Mass Transportation Administration; and the Massachusetts State Historic Preservation Officer.

* * * *

SECTION A

Formerly the Charlestown Division of the Boston Elevated Railway Company (BERy). Constructed in 1898-1901. Sullivan Square Terminal southerly through Charlestown to the North Portal of the subway. Included City Square, Thompson Square, North Station stations and the Charlestown drawbridge over the Charles River (built in 1896-1899 by the Boston Transit Commission). This section was abandoned in 1975 and was demolished in 1976-1977 when the new Orange Line subway was extended to Medford along the Boston and Maine Railroad right of way. Only Tower "C" was saved from demolition and moved to the Seashore Trolley Museum at Kennebunkport, Maine.

SECTION A-1

Extension of the Charlestown Division line easterly into Everett. Constructed in 1916-1919. Included only one station -- Everett (built by the BERy). Discontinued in 1975 and demolished in 1976-1978.

SECTION B

North Portal to Pleasant Street Station (now Broadway) via the outer tracks of the Tremont Street Tunnel which was adapted to elevated train use in 1901 by the construction of higher platforms. This link was returned to full streetcar use in 1908 with the construction of the Washington Street Tunnel.

SECTION C

Pleasant Street Station, up the incline, over the Boston and Albany and New Haven Railroad right-of-way tracks, and along Castle Street as an elevated structure, to Tower "O" (Bent #1200) on Washington Street. Constructed by the BERy in 1901 to link the Washington Street elevated to the South Portal of the Tremont Street Subway. Abandoned in 1908. Demolished in 1935. Incline portion remained until demolition in 1961.

SECTION D

Elevated structure along Atlantic Avenue from Tower C at North Station to Tower D at Washington Street. Constructed in 1901 and in use until 1938. Demolished in 1942.

SECTION E

North Portal to South Portal via Washington Street Tunnel. Built in 1904-1908 by the Boston Transit Commission. This section will continue in use after demolition of the elevated structure.

SECTION F

South Portal to Forest Hills repair shops. This line was originally known as the Roxbury Division of the BERy. The line is divided for identification purposes into the following sub-sections:

SECTION F-1

South Portal (Bent #1215) to Tower D at Washington Street. Built in 1908 by the BERy to connect the new subway tunnel to the Washington Street line of the Roxbury Division. Structural system is plate girder bents with longitudinal plate girders.

SECTION F-2

Tower D at Bent #1200 to Bent #1143 south of Dover Street Station. Built between 1899 and 1901 as part of the BERy Roxbury Division to Dudley Terminal. Plate girder bents with longitudinal truss girders.

SECTION F-3

Bents #1143 to #1068 along Washington Street. Built between 1899 and 1901 by the BERy. Includes Northampton Street Station. Arched truss bents with longitudinal truss girders.

SECTION F-4

Bents #1143 through #1100 to the Bartlett Street Yard. Built in 1899 to 1901 by the BERy as part of the original Roxbury Division. Includes the Dudley Terminal and the Guild Street yards and repair shops (discontinued in 1923). Plate girder bents with longitudinal truss girders. Loop around Dudley Station is marked by Bents T-1 through T-28.

SECTION F-5

This section is the beginning of the Forest Hills Division. Construction work began on May 2, 1906 and service began on November 22, 1909. Work included rebuilding the loops and platforms at Dudley Street Station and the construction of Egleston Station. Section F-5 runs as an elevated structure from Bent #1000 to #797 at the Arborway yards. Construction is plate girder bents with plate longitudinal girders. Green Street Station was added on as a suspended structure in 1912.

SECTION F-6

This section was a specially designed steel framework encased in concrete. Bents #979 to #783 include Forest Hills Station. Built in 1908-1909 by the BERy.

SECTION F-7

Bents #783 through #772 constitute the Forest Hills train storage yards and the repair shops. This extension was built in 1921. Repair shops built in 1923. Includes Tower "H". This section was demolished in 1984.

Dates of Construction: Sections F-1 through F-4: 1898 - 1901
Sections F-5 through F-6: 1906 - 1910
Section F-7: 1921 - 1923

Engineers/Builders: Boston Elevated Railway Company Engineering Department: George A. Kimball, Chief Engineer

Present Owner: Massachusetts Bay Transportation Authority (MBTA)
10 Park Plaza, Boston, Mass. 02116

Present Use: Remaining portion of the original BERy elevated Mainline Structure is currently in use as part of the MBTA's Orange Line rapid transit service from Forest Hills to Medford, Mass. The elevated portion (Section F-1 through F-7) serves from the South End through Jamaica Plain. The entire structure is slated for demolition when the new Southwest Corridor segment of the Orange Line rapid transit is completed.

Significance: This portion of the Orange Line elevated is historically significant as Boston's first elevated line, built during a period of world-wide interest and experimentation with elevated railways; and as the product of Boston's last privately-owned transit company, the Boston Elevated Railway Company.

Architecturally, it is significant for the quality of its original station architecture, which was designed by the prominent local architect, Alexander Wadsworth Longfellow. Later alterations were carried out under consultation with other leading Boston architects, such as Robert Swain Peabody and Edmund Wheelwright. In general, it represented the most advanced transportation planning of its day and is a good case study, on a small scale, of rapid transit at the turn of the century.

Historians:

Cynthia Zaitzevsky - Consultant in Architectural History to Kaiser Engineers, Inc./Fay, Spofford and Thorndike, Inc. (Coordinating Consultants to the MBTA for design and construction of the new relocated Orange Line -- Southwest Corridor Project)

Christine Fernandez Carvajal - Research Assistant

Calvin Opitz - Assistant on Structural Engineering Portion

Nikita Zaitzevsky - Assistant

BOSTON ELEVATEO RAILWAY COMPANY - ELEVATED MAINLINE STRUCTURE (MBTA - ORANGE LINE)

Submitted to the

HISTORIC AMERICAN ENGINEERING RECORD

by

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Orange Line Documentation

Chapter 1

Introduction and Significance of the Orange Line Elevated

Ever since Boston's earliest days Washington Street has been the main route for transportation between Boston and Roxbury and all other towns in the southwest portion of the larger city. The earliest stagecoach followed by the omnibus and later by horse-drawn and then the electric streetcar all used this route that was to become so heavily travelled that by the 1880's it had become imperative to build an elevated railway to provide rapid transit north and south of Boston. This section of the elevated structure from Oover Street to Forest Hills is the last remnant of a larger system of elevated railroads that served Boston at the turn of the century.

Boston was one of the last major American cities to build an elevated rapid transit line. The system was developed first in New York City and refined in Chicago, where third-rail electric motive power was first used.

Because it was built comparatively late, the Boston Elevated structure could use advanced rapid transit technology borrowed from many different sources. It is today a good case study, on a small scale, of the "State of the Art" of rapid transit at the turn of the century.

The Orange Line is significant not only from the point of view of technology but it also represented the most advanced transportation planning of its day. The BERy was the first company in the United States to include subways, elevated transit and surface trolleys -- all operating under one management.

In contrast to a system with many competing lines and companies (the usual situation in most cities), the public could transfer from one section to another of the BERy without paying more than one fare.

The early history of the Boston Elevated Railway and the Orange Line illustrates how Boston avoided the excesses of both total public control and free-wheeling private enterprise. All major cities building transit systems at that time had such problems in common, but in Boston a balance was struck: private management ran the system but government regulated it and also built the subways.

Although it was a small system, Boston's distinctive topography caused many difficult planning and engineering problems. Narrow curving streets, high density in the downtown area, limited arteries into the center of Boston, the hilly terrain, the Boston Common and Public Garden, and settled residential districts made the task difficult for the Civil Engineer. Contemporary descriptions of the system continually extolled the work. It remains today an impressive undertaking. By studying this system today, we learn on a modest scale about the problems of other transit systems of that era. We can also more fully appreciate the engineering capabilities that built this system.

Chapter 2

History of Public Transportation in Boston

Until the mid 19th century, Boston was a peninsula surrounded by water on three sides and connected to Roxbury on the south by a neck of land. Cambridge to the west and Charlestown to the north, connected to Boston by bridges, were the only other important communities. People lived close to their work and rarely travelled beyond their own communities. Except for private coaches and horses for the well to do, stagecoaches, omnibuses and, later, trains were the only methods of distant travel.

The omnibus, a horse-drawn bus with a rear entrance, was the first form of public transportation running on a regularly scheduled basis. In 1826 the first omnibus line in Boston opened. This ran to Cambridge, and by 1830 there was a similar line to Roxbury. Both were privately operated.

These early omnibus lines used approximately the same routes as at least two of the major branches of Boston's later public transportation system: The Red Line serving Cambridge/Boston and Orange Line serving Roxbury/Boston/Charlestown (HP-1) (For explanation of illustration designations, see Notes, Chapter 2.)

In 1856, the first horse-drawn street cars were introduced from Harvard Square, Cambridge to Bowdoin Square, Boston. Although steam railroads had been operating since the 1830s under charters from the Massachusetts Legislature, their service was limited largely to routes between cities and towns. By the middle of the century, Boston's population had increased greatly and there was a pressing need for rapid transit within the city.

The first such company was the Cambridge/Boston Company (1856), followed by the Metropolitan Railroad Line. This change underscored the evolution of Boston from a compact mercantile city to a larger one fed by the suburbs. Horse railways operating under a public franchise offered a faster and more comfortable ride than the omnibus. Under Massachusetts law, a franchise was a revocable right, granted by a municipality, to operate over public roads; thus the public had some control over the privately operated horse railways.

The Legislature and the Boston City Council subscribed to the then universal belief that free competition among many companies on public streets would provide the best service for the general public. In most large cities, especially New York and Chicago, there were many independent lines spread out over a wide geographical area. In spite of municipal corruption, the traction franchises still ensured reasonably good public service.

In Boston, because of local topography, the situation worked out differently. All traffic from the north and south was funnelled into the downtown along the two main downtown streets: Tremont and Washington. As Boston's population and business district grew, the surrounding towns became bedroom suburbs, and in turn caused the public transportation system to become overloaded.

By 1865 there were four main horse street railways:

The Middlesex Railroad - serving the North (Charlestown);

Union Railway - serving the West (Brighton, Cambridge, Somerville, Watertown, and Arlington);

Metropolitan Railroad - serving the Southwest (Brookline, Dorchester, Roxbury, West Roxbury);

South Boston Railroad - serving the South (South Boston, Dorchester).

In 1872 and 1881, the Highland Street Railway, serving Roxbury and Dorchester, and the Charles River Railway, serving Cambridge and Boston were established.

The lines were largely independent, and there were few crosstown lines or transfers. In the congested downtown area, the lines had to share a few tracks along Tremont and Washington Streets (HP-2, HP-3). Fragmented service and competing lines were not the answer to Boston's expanding business growth and population.

By 1860, traffic was 50 million riders, and, in 1885, it had climbed to 80 million. All large American cities had similar transportation problems and tried various solutions. In 1873, the cable car was invented in San Francisco and quickly was adopted in New York, Chicago and Washington, D.C. The horse-drawn street car had reached the limits of its effectiveness. It could not travel long distances at a high speed or carry heavy loads of passengers, and the cost of maintaining large stables of many horses was becoming prohibitive.

The cable car was the first practical method of increasing the effectiveness of mass transportation. Although the cable cars worked well in cities with broad straight avenues, they were not feasible on Boston's crowded streets, which had to carry several lines.

In Berlin, in 1881, Werner Siemens put into operation the world's first electric streetcar. This was followed by various attempts by Charles Van Depoele and Leo Daft in the United States to develop a workable electric streetcar.

The rapid development of technology in the 1880s provided a solution. The first practical electric streetcar system was realized by Frank Julian Sprague in Richmond, Virginia in 1887 -- a major step in transit history.

Meanwhile in 1886, Henry Melville Whitney, Eben Jordan and others had purchased a vast amount of land along Beacon Street in Boston and Brookline to develop as real estate. They also chartered the West End Railway to provide street car transportation into Boston. Whitney soon realized that all seven of the then competing roads would have to be combined into one economical line. His strong financial backing and his political role as an enlightened Democratic business man gave him the legislative support to create the requisite transit monopoly in Boston and its major suburbs.

Whitney, in less than a year, had organized the seven separate lines into a single integrated transit system using the "division system" of organization employed by major railroad companies. The best executives from the old lines were placed in responsible positions within the new company.

Frank L. Sprague's success with the electric street car in Richmond, Virginia convinced Whitney that electric traction was the solution to the shortcomings of the horse cars. He electrified the Beacon Street Line of the West End Railway in 1887, making Boston the first major city in the world to employ electric streetcars. By 1892, the trolley cars accounted for two thirds of the city use, and, by 1894, more than 90% of the lines were electrified (HD-100).

Contemporary accounts describe the progress of the West End:

> Within a single year this company, through the financial genius of its organizers, had accomplished the consolidation of all the great street railway companies of the city, operating 231 miles of track, the largest street railway system in the world.... It is probable that more problems of mechanical engineering and of railway administration have been grappled 'ab initio' by this one company than by any other team of street railway companies in the last fifty years. [1]

Although the West End provided excellent transit service, there were still problems. Ridership kept increasing, and the number of persons and streetcars going into downtown Boston began to choke the downtown streets again. There were many proponents of an elevated railroad to provide rapid transit. This had been the solution in New York City, where the first elevated railroad powered by steam locomotives was built. Chicago, another city with broad, long avenues, also had a network of elevated railroads beginning in 1892. Most Bostonians did not want the noise and ugliness of elevateds in downtown Boston, but the residents of outlying sections of the city were in favor of an elevated railroad that would shorten travel time into Boston. Charles Cheape has chronicled the complex struggles that went on in Boston as the public sought a solution to the traffic jams in downtown Boston. [2]

In 1891, the Legislature set up a Rapid Transit Commission to resolve the transit impasse. After many hearings and much research, the Commission made several recommendations for Boston's future transportation system. Three recommendations were especially important:

1) North and South Stations should replace the numerous railroad stations then serving Boston;
2) An electric streetcar subway should be built under Tremont Street;
3) A system of elevated and subway lines should be built to Charlestown, Roxbury, Cambridge, and Boston.

Stat. 1894 Chap. 548 -- An Act that incorporated the Boston Elevated Railway Company (the "Meigs Charter") and authorized numerous transit routes in the Boston Metropolitan area -- was the first regional approach to mass transportation. Later Acts were:

1) Stat. 1895 Chap. 440 -- An Act that authorized the construction of subways in the City of Boston;
2) Stat. 1896 Chap. 492 -- An Act that placed limits on the West End Railway in its use of the subway;
3) Stat. 1897 Chap. 500 -- An Act that authorized the Mass. Railroad Commission to use other systems besides the Meigs. This law also:
   a) Authorized construction of the Cambridge Subway;

b) Laid out routes of a proposed elevated railway;

c) Gave the Mayor of Boston authority to review and approve architectural and engineering plans of an elevated railway;

d) Established a five-cent fare with right of free transfer;

e) Required that the elevated railway run through a subway in the center of Boston;

f) Authorized construction of a new rapid transit bridge from Boston to Cambridge across the Charles River;

g) Authorized construction of a rapid transit tunnel to East Boston under Boston Harbor;

h) Declared franchise rights of the BERy to be irrevocable.

This was an unusually comprehensive and well thought out law that resolved most of Boston's transportation dilemmas. From this point on, good public policy and sound traction management were to be characteristic of the city's transportation system for many years to come.

After Henry Whitney left the West End Railway in 1893, that company lost its strong direction and failed to take advantage of the new legislation. A competing group of financiers headed by J. P. Morgan bought out the old Meigs franchise through the Boston firm of Kidder Peabody in 1895. The new directors had the requisite backing to finance construction of the "Elevated." They also proved able to overcome the public's objection to the structure. After some maneuvering, the Morgan group bought control of the West End, which, on December 9, 1897, was absorbed by the Morgan run Boston Elevated Railway. The new BERy now had both a financial and legal monopoly over most public transportation in Boston and its suburbs.

The Act of 1897 also resolved the dispute over the location of the Elevated structure. In 1B95, the Boston Transit Commission had begun construction on the Tremont Street Subway, which opened on September 1, 1B97. The new charter allowed the BERy to use the Tremont Street Subway for its elevated trains. This solution prevented the disfigurement of downtown Boston by elevated tracks while providing for their construction in the outlying suburbs of Roxbury and Charlestown.

The creation of the West End Railway and the BERy had understandably caused many reform minded individuals, led by Louis D. Brandeis, to fear that these giants would abuse their potential monopoly powers. It was a complex dilemma. There was little confidence in the ability of the often corrupt municipal governments to operate public transportation. Therefore the prevailing sentiment favored private enterprise. Yet only a company with near total monopoly powers could operate rapid transit systems effectively. Boston's eventual solution of public and private control was unique in the United States.

In other major American cities, traction companies managed to wrest total control from the public. By contrast, in Europe, municipal governments subsidized and completely controlled public transportation.

In Boston, the public component was the Boston Transit Commission chartered by the State Legislature. The Commission built the subway and leased it to the BERy to be used by its rolling stock. Thus the major capital expenditures for subway construction (more costly than an elevated structure but more desirable for use in the downtown area) would be undertaken by the City of Boston using its lower interest rate on bonds. The BERy, with the approval of the State and the City, then built the elevated structure and connected it to the subway. With its impressive financial resources, it could build the structure, the stations and the outlying street lines and operate the entire system. The public benefited because the monopoly was partially under control of the electorate. The individual rider benefited more directly from the five-cent fare and the right of free transfer.

NOTES
Chapter 2

[1] The Street Railway System of Boston - Street Railway Journal - April 1895.

[2] Charles W. Cheape, Moving the Masses - 1980.

References to illustrations are designated as follows:

HP-1 through HP-117 refer to Historic Photographs and are indexed in Appendix "C."

HD-1 through HD-100 refer to Historic Drawings and are indexed in Appendix "D."

MA-14-1 through MA-14-85 refer to Contemporary Photographs and are listed in the "Index to Photographs."

Chapter 3

Construction of the Elevated Structure 1898-1901

Once the legal problems surrounding the granting of a clear charter to the Boston Elevated Railway and its franchise to build a third-rail, electrically operated, elevated rapid transit system (using the then new multiple unit cars) had been resolved, the management of the BERy immediately began planning work for the proposed elevated structure.

George A. Kimball (1850-1912), a respected local civil engineer, was appointed chief of the Engineering Division to plan, design and construct the elevated railway. Kimball had served for eleven years as chief engineer for the City of Somerville and had gone on to distinguish himself as the engineer for the Metropolitan Sewage Commission. In the 1880's this agency had been primarily responsible for building a vast regional sewage system for metropolitan Boston -- a major civil engineering feat for its day.

Under the terms of Chap. 500 Acts of 1897, the BERy was first required to submit plans of the route to the Massachusetts Railroad Commission, which at that time was empowered to supervise all railroads and street railways, for review and approval. The plans then had to be approved by the Mayor and Common Council of the City of Boston.

The main public criteria were that the structure be light and airy and that the stations be of superior architectural appearance. Although New York City had been constructing and operating elevated railways since 1873 and Chicago since 1885 (HP-4), Boston was just now accepting this already standard form of rapid transit. New York's system of steam locomotives pulling wooden railroad cars had not impressed Bostonians. The structure of the New York Elevated (HP-5, HP-6), though elegant and open in the early stage of development, became less attractive as solid plate girders were used in the later extensions. The combination of noisy, smoky, dirty trains runnning over structures that blocked out the sunshine on the streets below was something that 8ostonians wished at all costs to avoid.

Moreover, with its sophisticated architectural and civil engineering forms, the Berlin elevated railway system set a standard of excellence which Bostonians tried to achieve (HR-14). [1] The BERy executives made every effort within their limited budget to avoid the mistakes of the New York systems and to emulate the successes of the Germans.

The basic design of the elevated structure was quite similar to the one developed in New York City (HP-7) and later perfected in Chicago. The preliminary designs were done under the direction of J.A.L. Waddell, who had been primarily responsible for the design of the Chicago system. The structural and civil engineering work was done by the Engineering Department of the Boston Elevated Railway Company. (Chapter 6...Structural Analysis and Description of the Elevated Structure discusses in greater detail the engineering aspects of the elevated structure.)

In general, the tracks were laid 24 feet apart on center except on narrow streets where they were 12 feet apart (HD-15). The rails were 85 lbs ASCE sections spiked to hard pine ties 16 inches on center, which in turn were bolted to the steel structure. Every fourth tie was extended out to support a sidewalk for track maintenance men. The trackwork was supported on bents consisting of steel columns supported on heavy concrete foundations. Heavy cross girders connected the columns and longitudinal girders with cross bracing supported the tracks. After a long design review process, the final approval for the system came on April 29, 1898.

Construction began on the Dudley Station site on January 23, 1899. Property condemnation proceedings had already commenced allowing for demolition of any structures in the way. Contracts for steel work along the Roxbury Division were awarded primarily to the Pencoyd Bridge Co. of Pencoyd Pennsylvania, a noted bridge building company, which already had considerable experience with the then new steel technology of fabrication and construction. Other steel work was executed by the Carnegie Steel Co. and the Pennsylvania Steel Co. Terry and Trench Co. of New York City were selected as general contractors for the steel erection primarily because of their experience in putting up elevated railroad structures in New York City.

While construction on some parts of the Elevated, in Charlestown and on Pleasant Street and Atlantic Avenue (HP-26, HP-27), was carried on in a normal fashion during the day, most of the work on the Washington Street segment was done at night. While efficiency and speed were considerations, the main reason was to avoid touching the live wires that fed the trolley cars running along Washington Street. (The lines were either removed from the portion under construction at night or else the power was cut.)

The BERy specifications stipulated that, wherever there were surface tracks, materials should be delivered to the narrow portions of the streets each evening after 7pm and that construction could take place only between the hours of midnight and 5am. Columns and girders were fabricated in the shops of the bridge companies doing the work, delivered by railroad car to the nearest siding and finally hauled to the site by trucks pulled by horse teams (HP-24). Photographs show how the first columns were erected on Washington Street near Dover Street (HP-19). After the cross members were in position, a traveller was installed to lift succeeding bents into place. Incandescent lights were also hung from the traveller. All steel members were riveted together. As each bent was set into place and the longitudinal girders attached, the traveller pulled itself forward along the tops of the girders on rollers to the next stop and installed the next section (HP-21, HP-22).

The work was carried out in five segments (HD-1):

a.) The Charlestown Main Division;

b.) The portion over the Charlestown Bridge which itself had been built in 1895 by the Boston Transit Commission;

c.) The conversion of the Tremont Street Subway, which originally consisted of four tracks for streetcars and was modified by the BERy to allow use of the high platform third rail trains on the two outside tracks;

d.) Building an inclined connector between the tunnel portal at Pleasant Street across the Boston and Albany Railroad tracks and Tower D at Washington St. (HP-9, HP-11, HD-5);

e.) The construction of the Roxbury Main Line along Washington Street (now called the elevated portion of the Orange Line) to the terminal at Dudley Street.

The line was planned as an elevated rapid transit railway between several stations spaced at long intervals for passengers arriving by surface streetcars. Since Boston streets were too narrow to allow more than two tracks, the New York and Chicago system of four-track lines consisting of express trains and local trains was not used. Since the BERy also had the unique advantage of controlling all local lines with the right of free transfer, the system of a limited number of stations spread far apart was feasible. The Roxbury Division was planned to service local lines at Dover Street, Northampton and finally Dudley. These street car lines served Brookline, Newton, Dorchester, Roxbury, Jamaica Plain, South Boston, and connected to other companies serving communities to the southwest of Boston as far as Walpole. Lines that formerly ran into downtown Boston either along the streets or, after 1898, through the Tremont Street Subway were now serviced by the Elevated, thus cutting down the time of travel.

Construction on the Castle Street/Pleasant Street connector began in the fall of 1900 just as the work on the Pleasant Street portal and the new viaduct was mostly done. Construction photographs show the rapid progress of steel erection during December 1900 and January 1901. To accommodate the longer multiple unit, three car trains inside the Tremont Street Subway, the outer two tracks were converted to third-rail use; and, inside each Subway station, high wooden platforms were erected to allow direct access to the trains. Since the

Subway had been designed with short trolley cars in mind, some of the radii were too tight, and certain walls and platforms had to be modified to allow clearance for the new trains. Most of the conversion work was done in the Subway in the week prior to the opening of the new elevated line in order to minimize obstruction to trolley cars using the Subway (HP-12, HP-13, and HP-18).

Steel erection on the Washington Street section began on August 19, 1899, and, by December 20, 1899, the structure had been erected as far as Sterling Street -- a remarkably fast performance by today's construction standards. (In 1980, a modern flat plate girder replaced the existing trussed girder to allow for the passage of the new Melnea Cass Boulevard under the structure (HP-40, MA-14-27)).

Project planning was done under what we now call a fast-track method. As soon as planning approvals were obtained, structural design and detail drawings were begun, and contracts were signed with steel companies for the required tonnage of steel. First column foundations were poured. Erection of the structure began as soon as possible. The main line structure was already up while architectural drawings for the stations were being completed. A completion date of December 1900 had originally been scheduled but was delayed a few months. The construction progress photographs show a last minute push in the winter of 1901 to finish the stations and other facilities. Concurrently with this work, the BERy was erecting the Atlantic Avenue loop (Section D), which joined the North and South Terminal Railroad stations and created a downtown transit circuit through the Tremont Street Subway (Section B) (HP-15, HP-27).

Dover Street Station was built in 1900 as a center platform type of structure. Like Northampton Street Station, it was designed to be used by four-car trains. After the opening, traffic on the elevated line was so heavy that the BERy decided to lengthen the station platforms to accommodate six-car trains originally and eight-car trains later (HP-30, HP-31, HD-50 through HD-54).

Schematic plans were drawn from 1906 on for extending platform lengths and increasing the station's capabilities of handling more passengers. The final plan of July 1909, in which the center platform and station were removed, the tracks brought close together, and a new station built flanking the tracks, was carried out. The same plan shows that the center platform and waiting room were eliminated (HD-58). When work was completed, the platform had been lengthened to accommodate an eight-car train.

While the new pavilion with waiting room and change booths on the intermediate level with the enlarged station meant a more functional plan capable of moving large numbers of passengers from streetcars to elevated train, the final architectural configuration of the station that emerged was clearly inferior to that of the first.

In April 1911, plans were issued for the erection of a temporary Dover Street Station built of wood that would temporarily replace the regular one while the complete renovations were under way (HP-32). [2]

Northampton Street was built according to plan and opened in 1901 and remains today as the only station that has undergone little change other than the lengthening of the platforms to accommodate six-car trains in 1908 (HP-34, HP-35, HP-36, HP-37, HP-39).

Dudley Station

Dudley Station was conceived as the southern terminal of the Main Line. Storage and repair yards were built at Bartlett Street, and a three-track spur extended from Dudley station along Washington Street to join them. The terminal itself was a complex tri-level combination of elevated train platforms and surface and intermediate-level platforms for transfer to street cars. This terminal serviced all the streetcars coming to Dudley Station from Jamaica Plain, Roxbury, West Roxbury, and parts of Dorchester. Southbound trains from Sullivan Square would arrive at Dudley, go around the loop, and pull into the northbound platform to unload and load passengers. These passengers came from streetcars that rode up the inclines feeding the east and west loops which acted as passenger platforms (HP-77). On the surface level, there were other surface lines bearing passengers. All these surface lines could take passengers as far out as Dedham, Westwood and Walpole(HP-41 through HP-50). [3]

The communities to the southwest of Boston were now more populous, and the original spine of Washington Street to Roxbury (now called the "Orange Line") extended beyond the Boston city limits. By 1900, the BERY decided to build a separate tunnel under Washington Street to connect the two ends of the Main Line with a direct link. Also the Tremont Street Subway could be returned to its former use as as streetcar subway. The Acts of 1903, Chap. 534 authorized the

Boston Transit Commission to build the tunnel and lease it back to the BERy, which would in turn furnish the tracks and operating equipment.

In retrospect, this decision seems wise. In its implementation, it represented another stage in the continuing struggle between the management of the BERy and the reform elements in Boston who feared the monopolistic potential of such a huge corporation. While the construction of the tunnel was done by the Boston Transit Commission, the interiors of the tunnels and the station furnishings were the responsibility of the BERy. The designs for the interiors and entrances were carried out under the direction of the noted Boston architect Robert S. Peabody. The tracks and related equipment were designed and installed by the Engineering Department of the BERy under George Kimball. Similarly the connection from the South Portal to the main line at Tower D (HP-16, HP-17) were also the responsibility of the BERy's Engineering Division as was the supervision of construction. The design of the tunnel station platforms allowed the use of eight-car trains along the entire line, and plans were undertaken to lengthen the platforms at all stations.

During 1903, the BERy decided to extend the elevated structure to Forest Hills. Again approval was sought from the Massachusetts Railroad Commission, which held the requisite public hearings, and from the Mayor and Board of Aldermen of the City of Boston. The approval for the structure with locations of stations was received on January 4, 1904. Soon after that date, engineering drawings were undertaken.

NOTES
Chapter 3

[1] For a more complete description of the Berlin Elevated Railway see: Report of the Rapid Transit Commission to the Massachusetts Legislature, April 5, 1892. This description was written primarily by Commission Member Congressman John E. Fitzgerald.

[2] The temporary Dover Street Station opened in July 29, 1912 and renovation work on the old station began. The new station opened December 7, 1912.

[3] On December 28, 1908 the platforms had been extended enough to allow eight-car train service.

Chapter 4

Forest Hills Extension

The extension of the elevated to Forest Hills was structurally less complex. With the exception of the Arborway crossing, plate girders, framed in both directions, were used in the structure. There are no extant contemporary records that explain this decision. Presumably economics dictated the use of a cheaper but less attractive system. Remnants of transmittal letters (in the MBTA files) indicate that the structure was approved by the Mass. Railroad Commission and by the City of Boston, and construction began on May 2, 1906 with the erection of the first bents at Guild Street (HD-37). [1]

The same system that had been used earlier on Washington Street -- bents delivered to the site during the day and set in place by the traveller at night -- was employed. Numerous construction photographs and drawings illustrate how the work progressed and reveal the methods of steel erection and track laying at that time (HP-78 through HP-90).

Again, progress in steel erection was rapid. By late August of 1906, the traveller had reached the Egleston Square station area and, by January of 1907, the structure was approaching Forest Hills. At this point, the chronology becomes unclear. The BERy annual report of December 31, 1906 notes that the company had not yet received approval for plans for new stations at Egleston and Forest Hills nor the changes at Dudley. Presumably, the management was preoccupied with the extra work on the Washington Street Tunnel and the numerous other projects then starting in Cambridge and East Cambridge.

Robert S. Peabody's daybooks for 1907 indicate that the BERy's committee of architectural advisors met repeatedly during that year reviewing designs, not only for Forest Hills Station and the Arborway crossing, but also for the Causeway across the Charles River to East Cambridge. [2] By early 1908, the designs for all stations had been approved, and work resumed on the elevated structure crossing the Arborway and on the Forest Hills Station itself.

Peabody, the chief architect to the BERy, appears to have decided to have a line of single massive piers supporting the main line structure. At this point, where the structure crossed the Arborway, the piers would be encased in concrete and made to look like rough hewn stone. Peabody and his committee of architectural advisors chose the same solution for the BERy crossing over the Charles River Oam (the Lechmere extension), which was designed at the same time.

The crossing of the Arborway (HP-103) was a particularly sensitive design problem, since the architects wished their structure to harmonize with both the landscape design of Frederick Law Olmsted and the nearby Forest Hills Railroad viaduct, a massive granite bridge designed by Shepley, Rutan and Coolidge from preliminary plans by the landscape architects and constructed approximately ten years before. Peabody chose concrete treated to simulate masonry as a suitable compromise (HP-116). This BERy station was also intended by the Mass. Railway Commission to connect with the then important Forest Hills commuter railway station and the West Roxbury branch line of the New Haven Railroad.

The new design for Dudley Station took an already sophisticated multi-level scheme and enhanced it. A new southbound platform for trains going to Forest Hills was constructed over Washington Street along the West Loop of the terminal. The mainline continued out toward Guild Street and along Washington Street to Egleston Square. Two new pedestrian bridges connected a new southbound platform with the existing terminal. The northbound platform built in 1900 was lengthened to receive the longer eight-car trains (HP-74).

At the same time, numerous changes were made on the surface level. The most interesting additions consisted of the two pavilion-type waiting rooms that were placed inside the old loops (HP-70). The trolley loops were also enclosed. Work on the new platform began in the summer of 1908. November 22, 1909 was the opening date for extended service from Forest Hills to Sullivan Square. Yet we know that heavy steel work was still in progress under the southbound platform after that date. Progress photos show that, while the new platform and bridges were almost complete, work on the framing of the new loop enclosures was just beginning in October of 1909. Work on Dudley Terminal was essentially completed by the summer of 1910, but final roofing was still being done in September of that year (HP-61 through HP-68).

Dudley Terminal has always been a busy area, and minor changes have constantly been made in the interior to improve passenger flow and expedite movement of transit vehicles. In 1948 the east pavilion was completely rebuilt to allow use of the trackless trolleys that were replacing the old electric streetcars in the Roxbury/Dorchester area. The center pavilion was removed and a new roof with factory skylights installed. Gradually the service at the West loop was phased out. In the early 1970's, that loop was completely demolished. Old photographs are the only record of the appearance of Dudley Station in its prime. By the 1960's, the MTA had substituted bus service for the trackless trolleys. The surface area under the station (Ziegler Street) formerly used by trolley lines became a major bus connector (MA-14-28 through MA-14-43).

Egleston Station was planned to relieve Dudley Terminal and serve as a collection point for passengers coming in by streetcar from points in Jamaica Plain and Dorchester. In its construction, concrete passenger platforms were used for the first time on the line. Originally a stairway descended right into the middle of Washington Street at the intersection of Columbus Avenue. In 1916 a trolley barn built with a low cost factory type of construction was added as a station for surface loading of passengers. A bridge and escalator connected the new structure with the existing structure (HP-93 through HP-97). The architect for the station is unknown.

Forest Hills Station was an extension of the Arborway crossing of the main line. Designed by the architect Edmund S. Wheelwright, a member of the advisory committee, under the direction of R.S. Peabody, it was framed of heavy steel encased in concrete. The BERy built an extension of the regular steel bent construction system, beyond the station, to allow trains to reverse direction over a diamond shaped crossover. This work also included construction of a spur-track incline out over the present Arborway yards for storing trains. On November 5, 1921, the Forest Hills station structure was extended southward. A storage yard was built, and the Arborway inclined yard was removed. By 1923, a new car repair shop had been built which replaced the smaller shops and storage yards at the Guild Street yard (HP-104 through HP-117). [3]

Green Street Station

When the BERy submitted its first proposals for the Forest Hills extension to the Mass. Railroad Commission, the plans included a site for a passenger station at Green Street, but that particular location was not utilized at first. It was only after the extension had been opened that the BERy decided to build Green Street Station in 1910. The simplest construction method was used: a suspension system of hanging the lobby from the bottom of the tracks and building a steel-frame concrete platform with canopy on top of the structure. The station was completed and opened in 1912 and served as a local station for commuters from the neighboring sections of Jamaica Plain (HP-98, HP-99).

Egleston Square Sub-Station

The extension of the Main Line to Forest Hills required the construction of a sub-station at Egleston Square for the conversion of alternating current generated at the South Boston Plant to direct current for use in this portion of the rapid transit system. The station was designed by Robert S. Peabody and consisted of a steel framed building to house the sub-station equipment. The exterior was of stucco trimmed in brick (MA-14-56).

NOTES
Chapter 4

[1] Copies of Letters of Transmittal between the BERy and various governmental agencies are on file in the MBTA Plan File Room.

[2] Robert S. Peabody, Daybooks, 1907-1909. Courtesy of Professor Wheaton A. Holden, Northeastern University, Boston. The committee consisted of Boston architects Charles A. Coolidge, Charles D. Maginnis, Clarence H. Blackhall, Ralph Adams Cram, and Edmund M. Wheelwright under Peabody's direction.

[3] For additional information on the Forest Hills Station see the September/October 1984 issue of Rollsign (BSRA).

Chapter 5

Architectural Description of the Stations

The orginal way stations of the Boston Elevated Railway were conceived as parts of a single theme, designed by a single architect, and constructed over a short period of time. They reflected a much more unified concept than the stations that stand today. Indeed, the winning design submitted by Alexander Wadsworth Longfellow, Jr. (1854-1934) was often illustrated in trade journals by a single, "typical station" (HP-B). [1]

The style of each station was "early French Renaissance," combining classical and Gothic features in true Beaux Arts fashion. The result, everyone agreed, was appealling for the "lightness, symmetry and beauty" of the stations themselves and of their relationship to the graceful, web-like structure that weaved over the streets of Boston.

The "typical station" of 1901 dotted the original line between the Sullivan Square and Dudley Street terminal stations. Subsequent alterations have obscured the original Longfellow design. Of the "Roxbury Division's" first stations -- Dover, Northampton and Dudley Street stations -- only Northampton Street has retained its original character. It reveals perhaps the most enduring merit of the original design: stations of competent but unremarkable design, which were adapted in every sense to their site: the elevated structure. The qualities that are aesthetically noteworthy in the elevated structure -- the sense of motion, light and air; the expressive, curvilinear grace of the truss-work;

subtle adaptations to the site; rhythmic, elegant arches and carefully crafted details -- are also found in the stations.

DOVER STREET AND NORTHAMPTON STREET STATIONS

Dover Street and Northampton Street Stations were originally "island" stations, perched between two tracks on top of the elevated platform, enclosed in rectangular huts with Renaissance details. Northampton Street Station was approximately 12 1/2 x 40 feet long, and Dover Street station was slightly longer. Each had a covered platform 160 feet long, and was sheathed in copper panels and capped by an overhanging copper-paneled ridge roof brindled with standing ribs. Standard features were three dormer windows and a central Beaux Arts cupola flanked by two finials, one over each gable. On the east and west elevations, a band of sash windows (configured slightly differently at Dover and Northampton Street Stations) was surmounted by a diamond-paned clerestory and separated by copper paneled pilasters decorated with a diamond motif. The diamond motif was repeated on the copper panels just beneath the windows and pilasters (HD-52 through HD-63).

The stations were reached by means of iron stairways of approximately 38 steps, covered by a running copper canopy that was ribbed like the station roof. Each landing was covered by a copper pavilion roof supported on four posts and decorated with a copper finial. A wrought iron balustrade enclosing the stairway on either side was decorated with scrolls and copper panels.

At the first landing, the passenger entered an arched double door with diamond-paned lights and semi-circular transom. The second flight of stairs led directly to the waiting room lobby, where the passenger purchased his ticket at the ticket office. He waited for the train inside the waiting room (similar to HP-38) or outside the station on a canopied platform. (When he disembarked on the opposite side of the platform, he descended a connecting exit stairway which led directly to the street.)

The station interiors were sheathed in oak, with hard pine for the floors in both the station rooms and platforms. The furnishings, also designed by Longfellow, included a ticket office, turnstiles, wooden benches, porters' closets and rest rooms. The ticket offices, octagonal or semi-octagonal booths that stood in front of the entrance stairs, were distinguished by their classical detailing, elaborate iron work and varied materials. To either side of the ticket window were arched, sash or spring-balanced windows. Decorating the ticket window were a keystone and scrolled, wrought-iron grille. A thick marble slab served as the ticket ledge. The lower portion of the office was sheathed in wood and copper, and stood on a base of wood and Tennessee marble. At Dover Station the ticket office was originally crowned by an oak balustrade with knobbed posts above a paneled architrave. In the early days of operation of the trains, passengers first bought a ticket and surrendered it at a turnstile (HD-61, HD-62, HD-63).

In the center of the room were a pair of back-to-back wooden benches. Beside these were the restrooms and porters' closets. Oak sheathed the interior walls and separated the sash windows. The ceiling, also sheathed in oak, was patterned in the center panels with the diamond motif. Incandescent and arc lights illuminated the interior (HP-38).

The platforms were notable for the quality of their engineering details. (MA-14-22).

DUDLEY STATION

Dudley Station, the southern terminal until 1909, was designed to harmonize with the way stations, punctuate the elevated railway with a strong design, and meet the requirements of its function as a turn-around, transfer station and junction of several surface lines. Its complex vehicular circulation was explained in a Boston Elevated Railway Company publication:

> The rapid-transit track passed through the center of the station, with a loading and unloading platform on each side. Surface cars reached the same level as that of the rapid-transit platforms by easy inclines, a loop track being provided on either side of the station so that transfers between surface cars and rapid-transit trains could be readily made. Through cars ran through the lower level of the station and the upper level was reached by an adequate number of stairways. [2]

The elevated platforms to either side of the station were covered by copper canopies which flanked the station below the clerestory and extended north on the east and west sides. The central, rapid-transit entrance on the north end was arched and flanked by stairways which led to the surface level. Two cupolas surmounted the station's ridge roof; and a finial stood on each gable (HD-64 through HD-69).

To either side of this entrance were enclosed waiting rooms, each 18 feet square and surrounded by paired, sash windows with diamond-paned upper sashes (HD-70 through HD-73). The exterior elevation was framed by a row of copper panels and pilasters embellished with the diamond-triangle motif. Set in the north-easterly and northwesterly corners of the station, these waiting rooms were entered via the elevated loading platforms under the station's main roof. The exteriors featured a ribbed mansard roof and an entrance decorated with classical ornament, a tympanum with a paneled roundel, a scrolled arch, and a finial. The interior was paved with terrazzo.

The central loading platform was spacious, elegant and richly furnished. In addition to the two enclosed waiting rooms, it housed a magazine and tobacco stand (HP-49), storage rooms, a ticket office, public toilets, built-in wooden seats and, to either side of the platforms, wrought iron stairways leading to the central waiting room, just below track level.

An oak ceiling was carried on a series of open steel trusses gracefully arched and supported below the clerestory on copper brackets. The arch theme was continued in the station walls, which were open to the unloading platforms outside the station via an arcade consisting of uncovered steel columns and copper-paneled arches springing from copper brackets. The arches were embellished with keystones and copper-paneled roundels in the spandrels. Above these were rectangular paneled spandrels with a triangle/semi-circle motif, and a clerestory of diamond-paned sash windows (HP-50, MA-14-36).

In the center of the room, to either side of the platforms, iron stairways provided access to the central waiting room on a level below the track. This was an octagonal room, approximately 160 feet in diameter. Richly articulated, it featured an oak dado with stone mouldings, buff brick walls, a maple floor and a coffered oak ceiling.

In 1909 Dudley Street Station was altered to provide for separation of loading and unloading traffic, and for the accommodation of eight-car trains. The east and west loops were rebuilt, each containing a polygonal waiting room pavilion (HP-69). These had circular clerestories of paired, diamond-paneled windows, a copper pavilion roof with standing ribs and a finial on top. The interiors were lined with built-in wooden seats. A polygonal wooden bench, shaped like the exterior of the pavilion, stood in the center. The walls were sheathed in oak, and were decorated with paneled arches and keystones. New loading and unloading platforms were built, accessible by new covered bridges with stairway connections (HP-68 through HP-74, HD-73, HD-74).

A reinforced concrete bus loop was built in 1948 to accommodate the trackless trolley (MA-14-32, MA-14-33).

EGLESTON STATION

Egleston Station, built in 1909, was the first station in which the platforms, galleries and stair landings were designed for reinforced concrete (HP-93). A 350-foot platform was built to accommodate eight-car trains. At this time the other elevated station platforms were also enlarged for the same purpose (HD-80). The waiting room station on the first level was suspended from the track support system and was reached by cantilevered stairways. The design was a simplified, unembellished version of the original Longfellow station; a rectangular structure, 44' x 22' with a half copper ribbed roof, windows, pilasters and copper panels (HD-81, HP-94, HP-95). More decorative emphasis was given to the platform, which was positioned above the station on the second level. It featured a ribbed copper canopy supported on iron columns and a gallery with arched, sash windows and keystones, which the passenger entered via a waiting room stairway (HP-96, HD-81). The waiting room contained an alcove on the west side, wooden benches, and an octagonal ticket office which was sheathed in copper, finished in white ash, and detailed similarly to the original ticket offices. The floors of the waiting room, platform and gallery were of reinforced concrete (HD-82, HD-83).

In 1916, an enclosed footbridge with a patterned ceiling was constructed to connect the original station to a surface car station (HD-84, HD-85).

GREEN STREET STATION

References to the original construction of Green Street are scarce. However, there have been few major changes made to the exterior since it was built in 1912. Its design marks a clear departure from the Longfellow stations. The east and west elevations were devoted almost totally to large, plate glass windows. Above these were copper spandrels decorated with an unusual circle-lappet motif. The window-spandrel composition was unified by a copper stringcourse and paneled pilasters decorated with the circle-lappet motif. Above the stringcourse was a clerestory of smaller plate glass windows separated by recessed pilasters (HD-89). Most of the station's interior was sheathed in bead ash, including the ticket office, which featured an ash grille in the ticket window and a center fence with an ash handrail (HD-87, HD-88). In 1976, the interior was completely rebuilt after it was badly damaged by a fire.

FOREST HILLS STATION

More is known about Forest Hills Station, including the name of its designer, Edmund March Wheelwright, an important local architect who also designed Park Street Station. Not only was this station widely publicized at the time of its construction, but it has been virtually unaltered since its erection in 1909. Built as a terminus, it markedly differed in design and construction from earlier stations. Wheelwright intended it to harmonize with the Arborway, part of the Boston park system designed by Frederick Law Olmsted. Wheelwright was also clearly influenced by the stations of the Vienna Stadtbahn designed by Otto Wagner in the 1890's, particularly the Gumpendorfer Strasse, Josephstadter Strasse, and Alser Strasse stations on the Gurtellinie. [3]

A massive structure of elegant proportions, it was constructed of reinforced concrete and embellished with copper details. Trains approached the station on a reinforced concrete viaduct which carried a double-track line (HP-110, HP-112). High concrete balustrades minimized noise. Supporting the viaduct was a single row of massive steel posts encased in concrete and supported on foundations 11'6" square and 12' deep. The main framing was of deck construction with steel plate cross and longitudinal girders. All timber work, including ties, guard rails and feeder box, was of hard pine.

The exterior of the station consisted of two concrete pavilions joined by a long, double platform which was supported on a massive arcade of reinforced (HP-113, HP-114) concrete piers. Spanning the arches were two tiers of large, double-hung glass and wood windows, the upper tier adjusted in shape to the curvature of the arch. The north pavilion was supported on two concrete posts and a massive central pier. Trains entered an arched portal, which was framed by copper pilasters and keystone. Recessed copper pilasters, panels, and crenelations embellished the cornice (HD-93 through HD-96). Inside the pavilion were waiting rooms. The track was open to the sky; the platforms on either side were covered by copper canopies supported on posts, braces and diaphragm arches. The south pavilion was similar to the north pavilion except for its roof, which was hipped instead of flat. [4] Despite its scale and material, the overall effect is light and graceful. The station is admirably adapted, not only to its site but to the elevated system as a whole (HD-97, HD-98, HD-99).

NOTES
Chapter 5

[1] Engineering News (Supplement), March 31, 1898; Railroad Gazette (Vol XXX, no. 16), April 22, 1898; Street Railway Journal (Vol. XIV, no. 9), Sept. 18, 1898, 501.

[2] BERy Co., 50 Years of Unified Transportation in Metropolitan Boston - 1938.

[3] Heinz Geertsegger and Max Peintner, Otto Wagner, 1848-1918 (New York: Rizzoli, 1979), pp. 47-78.

[4] In March 31, 1910 a large illuminated sign reading "Elevated" was installed over the South Portal.

Chapter 6

Orange Line - Structural Analysis and Description of the Elevated Structure

Section F-1 thru F-7

I. General Description

The Orange Line south elevated structure rises from the South Portal of the Washington Street Tunnel, and then runs along Washington Street to its terminus at Forest Hills. The great majority of the elevated structure consists of one of three variants of a "regular elevated railway deck type" [1] structural bay constructed of sections built up of riveted assemblages of rolled structural steel. The rolled sub-components are all standard sections with the exception of the channels used as column flanges. These were "specially rolled ... with rounded corners, thus allowing abundance of wheel room and nothing to catch the hubs." [2]

HD-15 Generally the structural action of these bays is as follows. Tracks carry the train loads through their supporting ties, to the longitudinal trusses or girders. These longitudinal
HP-21 members frame into the top girders of transverse bents. The
HD-9 transverse girders frame into two columns, supported by
HD-26 concrete foundations, resting on solid rock, compacted earth or pile clusters, depending on subsoil conditions. [3]

The longitudinal members occur in pairs, generally under the two tracks, and the members of the pair are braced together laterally by a system of transverse and/or diagonal members in the horizontal plane. They are further stabilized by a system of "sway frames" consisting of crossed members running
HD-14 from the top chord of one truss or girder to the bottom chord of its mate. The longitudinal system is supported by an expansion pocket at the end of every third span. Between these points rigid connections were used. Later analysis revealed this to be one of the few design faults in the system. The designers considered the longitudinal system to act as a series of simple spans, but the rigid connections made them approximate three span continuous beams. (See Anderson - Nichols & Co. report). [4]

There are three principal variations upon the "standard" bay described above. The first consists of both longitudinal and transverse girders constructed from plate girders. The second consists of transverse girder bents and longitudinal
HD-19 trusses. The third consists of longitudinal trusses supported by "arched truss-bents ("type F")". These three carry the bulk of the elevated system. There are many very minor variations along the right-of-way to accomodate local conditions and more substantial variations at a few special
HD-15 stations. The design drawing "Typical Elevations and Cross

Sections" shows the typical support conditions and their reasons for use which are principally a function of street width.

Variations in the supporting structure occur to support the additional functions required at stations and in response to special structural requirements. Examples of the latter include the special bent transverse girders composed of hybrid truss and plate girders specialized additional longitudinal bracing, extra bracing for unusually high bents longitudinal members with raised bottom chords longitudinal members of varying depth and other atypical bracing.

For purposes of discussing specifics of the structure, the right-of-way has been divided into a series of segments starting in the north and proceeding southward; these are defined by the section:

1. South Portal to Tower "D" - Section "F-1"
2. Tower "D", past Dover Station, to the Cathedral - Section "F-2"
3. The Cathedral to Thorndike Street (Bent #1068) - Section "F-3"
4. Thorndike Street thru Dudley Station to Guild Street - Section "F-4"
5. Guild Street to the Arborway - Section "F-5"

6. Arborway to the Forest Hills Station and to the storage yards. Sections "F-6" and "F-7"

II. Description by Segments

(1) SECTION F-1

South Portal to Tower D (Bents #1215-#1200)

The initial segment of the elevated system, after it emerges from the Washington Street Tunnel, and up to the point where it crosses the current location of the Massachusetts
HD-32 Turnpike (formerly the B&A R.R.) does not run colinearly with
MA-14-2 a street on grade. It does, however, cross some minor streets. Since no street runs beneath the rail line, the designers chose to support the system with fully braced fra-
HD-30 mes, presumably for reasons of structural efficiency. The bracing consists of "X's" running from the support girder at one column to the base of its paired column. Since the transverse girders are relieved of their moment resisting function, they are relatively shallow. In addition, the
HD-31 spans are short in this segment and the longitudinal members are framed with girders.

(2) SECTION F-2

Tower D past the Cathedral (Bents #1215-#1143)

After crossing the turnpike the structure joins Washington
HD-6 Street. This is the location of the original "Wye" con-
MA-14-3 necting the Roxbury Division with the Atlantic Avenue loop
MA-14-4 (Section D). Elements of the original framing remain along
with the original switch tower and its supports.

MA-14-5 Supplementary cross girders span between the columns of bents
1198 and 1199, forming secondary "transverse" bents, presu-
mably to support the old "Wye". Remaining track support gir-
ders and trusses run perpendicular to the later alignment at
this point.

HD-18 Approaching Dover Street solid girder bents were employed.
MA-14-7 At the station the longitudinal trusses diverge although the
MA-14-12 tracks now run in a straight line. This appears to be a
HP-28
HP-32 vestige of the station before its rebuilding in 1912. Upset
MA-14-10 girders were employed for track support at the station pro-
viding headroom for the ticketing lobby below the station.

HD-24 These are interesting in that no secondary framing was used,
but instead oversized ties span between the bottom flanges of
the girders to carry the rail loads. Platforms are carried
MA-14-12 by additional longitudinal girders. At the station, the
HP-33 standard girder bents are fitted with cantilevered
outriggers, supporting the platform structure.

MA-14-13 Proceeding south from the station, Washington Street starts out quite narrow, and the bents span from sidewalk to
MA-14-14 sidewalk. Shortly, the street widens a bit, and short spans replace the larger ones with columns coming down into the street. Some solid web and some trussed girders are used.

As Washington Street veers to the West, a substantial offset occurs between the road alignment and the rail alignment
MA-14-15 giving rise to very asymmetrical loading conditions. These
MA-14-16
MA-14-17 are marked by a series of special transverse bents some with
HD-22
HD-16 cantilevers and some with a hybrid truss - plate girder form
HD-23
of construction.

(3) SECTION F-3

The Cathedral to Thorndike Street (Bents #1143-#1068)

HD-19 As Washington Street passes the Cathedral it starts to widen.
MA-14-18 The rail line supports become variants of the type "F" arch-truss bent. The road and track alignments still differ, inducing asymmetry in the supporting structure. Columns are frequently centered under one track, and a shallow trussed girder is used in place of the full arch design. Cantilevers are employed as necessary to resolve the alignment differences.

Beyond the Cathedral, Washington Street becomes wider and regular. The standard elegant type "F" arch-truss bent supports the system here. Since columns are directly under the track loads, the bents could be designed as light, efficient

HD-20 forms although subsequent analysis has revealed deficiencies in the lateral force resistance of the design. (See

MA-14-20
HP22
HP23

Anderson-Nichols & Co. report). [4] Washington Street is quite level in this area, so that bents have a fairly constant height. Longitudinal members are trussed adding to the light "airy" appearance of this portion of the line. Engineering News observed, "The structure ... leaves the street much more open and unobstructed than does the usual elevated railway, and the cross struts being arched present a handsome appearance as well." [5]

At Northampton Station, columns move to the ends of the

MA-14-24 bents, apparently to allow more horizontal clear space below

HD-17 the tracks for surface vehicles. An additional pair of

HP-35 longitudinal trusses supports the platform areas between the

HP-39 tracks. In place of an arch, the transverse bents have a constant depth with trusses used under the platform areas and

HD-26 solid web girders under the station house.

(4) SECTION F-4

Thorndike Street to Guild Street (Bent #1068 - Guild Street)

Beyond the station, Washington Street continues regularly till it starts to aproach Dudley Street and the type "F"

MA-14-26 bents continue through #1068. After this, the tracks converge and the street narrows and winds to the west. Girder type transverse bents with a three-hole style knee brace span
MA-14-42 the street to carry the longitudinal support members which continue as trusses.

MA-14-28 Dudley Station was the original terminus of the system. The
HP-41 line terminated in a loop of fairly tight radius, necessi-
HD-29 tating considerable additional lateral bracing and support. Around the tight curve, non-prismatic transverse girders were employed to create the necessary banking. Even so, this curve was the scene of a major derailment in 1910, shown in photographs HP-59 and HP-60. In addition, platform and station supports, as well as support for the elevated surface line loops complicate the appearance of the structure here.

In the areas of the station where "a minimum elevation of the
HD-25 tracks was desired, with the standard head-room below for street cars and where it was necessary to prevent drippings, a special through girder and solid floor construction was employed." [6]

Supporting structure for three tracks wye off from the loop
MA-14-44 and continue south along Washington Street, forming part of
MA-14-45 the former Guild Street Yard. The end of the yard segment marks the end of the old style trussed longitudinal girders,

HP-53 and the end of the knee braces with three holes. Two of the
HP-54 three yard tracks form the connecting link to the line exten-
MA-14-46 sion south of Dudley Station.

(5) SECTION F-5

Guild Street to the Arborway

HD-37 Proceeding southward from Dudley Station, Washington Street
HP-83 becomes narrower and passes through a much hillier area. The
HP-84 portion of the rail line which follows this section presents
a more utilitarian aspect than did the original portion north
HP-85 of Dudley Station. In addition to solid web plate girder
HP-86 transverse bents, longitudinal members are now structured as
solid web members. Knee braces have been redesigned with a
HD-38 single hole, giving the whole structure a heavier appearance.
In certain areas, Washington Street dips markedly, and extra
HD-42 high bents were designed to maintain the rail grade. These
Bents, #920 through #932 and #962 through #969, have an
additional line of secondary bracing comprising a laced
MA-14-53 member spanning between the columns. "X" bracing runs bet-
HP-82
ween the transverse girder and the horizontal brace.

MA-14-47 Conversely, when Washington Street passes over a hill, very
short bents are used, such as number 947. Where cross
streets occur at an area of short bents, longitudinal girders
have been redesigned with lower chords which arch upward to

gain clearance. The arch is usually composed of curved
MA-14-62 segments at the span ends, while the center of the span is still ususally straight. Occasionally the bottom chord is formed as a single long curve.

MA-14-50 Track and street do not always align in this section, but the
HP-88 misalignment is not so great as in the northern portion.
HD-39 Individual girders are adjusted to accomodate the varying load position, usually by varying the size and location of flange cover plates and web stiffeners, but occasionally by means of cantilevered outriggers.

HP-94
HD-83
HD-82

Standard track support framing is employed at Egleston Station, with the exception of one span where upset girders, with floor beams and stringers, were used to gain headroom over the passenger access ways.

This section of Washington Street from Egleston Station to Green Street Station becomes very regular, and the track sup-
MA-14-63 port structure is also very regular. Typical bays occur throughout the section, modified only by the occasional arch-chord longitudinal girders as described above.

HP-98 Green Street station was added to the system in 1912 after
HP-99 the main design was complete. As a result, the principal
MA-14-64 track support structure is unchanged through the station.

MA-14-66 The ticketing area is hung as a gallery under the main longi-
MA-14-68 tudinal structure.

(6) Green Street to Forest Hill Terminal

HD-41 Proceeding South from Green Street, the typical framing con-
HD-48 tinues until the Arborway is approached. This is the final
terminal on the system and its design varies greatly from the
rest of the line. The support structure is steel encased in
HP-104 concrete, with single pylon-like columns carrying both longi-
HP-106 tudinal supports by means of a "Tee" shaped double can-
tilevered head. Each pylon actually contains a cluster of
HD-44 four steel columns, laced transversely. The longitudinal
HP-109
HD-45 support is encased in concrete with a long arched soffit
HD-46
HD-47 spanning the center line between the columns.

HP-114 Within the station, two-span transverse bents support longi-
tudinal girders. The exterior columns of these bents are
encased in the concrete outer structure of the station. The
longitudinal structure comprises both conventional deck-type
girders and upset through-type girders. The major design
MA-14-78 features of the station are more architecturally noteworthy
rather than structurally exceptional.

South of the Forest Hills terminal, regular plate girder
MA-14-82 transverse bents carry the tracks along Washington Street a

short distance, and begin a gentle grade to the existing storage yards at the end of the system.

III. Subsequent Analysis

Between 1972 and 1973, the consulting firm of Anderson-Nichols and Company, Inc. prepared an analysis of the state of the Orange Line at that time. Their report [4] gives a detailed description of the corrosion and disrepair the elevated structure had fallen into, after 30 or more years without repainting. While that discussion is not directly relevant to this description, their analysis contains some interesting information. The original structure was very conservatively designed, with a maximum design stress of 16 kips per square inch, and most areas they investigated developed stresses around 10 to 12 kips per square inch. This overdesign was responsible for the continued serviceability of the structure, even though corrosion amounting to as much as 30% loss of original metal had occurred.

Design inadequacies highlighted by sophisticated computerized analyses were very few and were mentioned above. Their conclusions were that, corrosion notwithstanding, "the structure was found to presently be in an operable condition." A program of repairs and painting was proposed and carried out which extended the useful life of the system into the 1980s.

NOTES
Chapter 6

[1] Engineering News, Vol. XLI, No. 19, May 11, 1899, p.304

[2] Engineering News, Vol. XLIII, No. 11, March 15, 1900, p.180

[3] Engineering News, Vol. XLI, No. 19, May 11, 1899, p.304

[4] Structural Investigation and Analysis, Elevated Structure and Stations, MBTA Orange Line. February 1973.
Consultants: Anderson-Nichols and Company, Inc.

[5] Engineering News, Vol. XLIII, No. 11, March 15, 1900, p.180

[6] Engineering News, Vol. XLI, No. 19, May 11, 1899, p.304

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Notations

Notations

APPENDIX A

Chronological History of Orange Line up to 1918

	Boston Rapid Transit Boston Elevated Railway and Orange Line	General Transit in Boston	Surface Transit in Other Cities	Rapid Transit in Other Cities
1790-1820		1793: Stagecoach service established between Cambridge and Boston over West Boston Bridge		
1820-1850		1826: First omnibus service established between Cambridge and Boston	1831 - New York: First Omnibus put into service in New York City. 1832 - New York: New York & Harlem Railroad established. First horse drawn street railway. 1833 - Paris: Paris begins to use horsecars in 1833	
1850-1870		1852: Cambridge Horse Railroad Company begins to raise capital for first horse drawn street car in Boston. Route from Harvard Square, Cambridge to Bowdoin, Mar. 26. 1856. Sept. 1856: Metropolitan Railway Company open first line from Boston to Roxbury. Route from Washington @ Boylston Sts. to Eliot Sq. 1857: Horse railway to Charlestown opens. 1858: Horse railway to South Boston opens.	1850's - New York: Lines are built on 3rd, 6th, and 8th Ave.	Jan. 9, 1863 - London: Operations begin in first train subway with steam/coal burning locomotives. July 3, 1868 - New York City: First official demonstration of an elevated passenger elevated railway pulled by a cable system. Built by Charles T. Harvey.
1870-1880	1879 First elevated railway along Tremont Street proposed in 1879.		Aug. 1, 1873 - San Francisco: Andrew Hallidie demonstrates first street cable car in San Francisco. June 14, 1876: Franchise granted to first cable car in San Francisco.	1876 - New York: New York Elevated Railway begins regular operation of trains. Steam locomotives. ("dummies")
1880-1890	Feb. 20, 1888 First public demonstration of Meigs Elevated Railroad.	1886: West End Street Railway formed. Nov. 12, 1887: West End consolidates all six major street car lines into one system. 1888: Frank Sprague demonstrates successful use of electric street car to Henry Whitney in summer of 1888 in Richmond, VA.	1881 - Berlin: Werner Siemens builds first commerical electric streetcar in Berlin Lichterfeld. 1882 - Chicago: Cable car line opens in Chicago. 1882 1883 - Philadelphia: Philadelphia opens cable car in 1883. April 15, 1886: Charles J. Van Depoele demonstrates first American electric traction motor street car in Mongomery, Alabama on a city-wide basis.	1882 - Berlin, Germany: Elevated viaduct railroad opens in Berlin. Trains drawn by steam locomotives along 2 1/2 mile, $16,000,000 system. 1885 - Brooklyn, New York: First elevated system opens in Brooklyn. 1885 - New York City: Leo Daft experiments with electric locomotive on 9th Ave. line. 1886 - Kansas City, MO: Elevated railroad constructed in Kansas City - six miles long.

	Boston Rapid Transit Boston Elevated Railway and Orange Line	General Transit in Boston	Surface Transit in Other Cities	Rapid Transit in Other Cities
1880-1890 (Cont.)			Feb. 1882: Frank Julian Sprague puts into operation the first truely practical electric street car service in Richmond. VA capable of running on a city-wide basis, and using a single wire overhead trolley.	
1891		June 18,1891: Appointment of Rapid Transit Commission to study transportation needs of Boston		1891 - Chicago: Mathew Forney invents new compact steam locomotive for South side line.
1892				June 6, 1892 - Chicago: Service begins on first runs of the South Side Elevated Railroad.
1893				
1894	July 2, 1894: Incorporation of Boston Elevated Railway Company under Chapter 548, Statutes of 1894.	July 2, 1894: Formation of Boston Transit Commission under Chapter 548, Statutes of 1894.		
1895	J.P. Morgan Syndicate buys control of B.E.R.Y. from Meigs group.	March 28, 1895: Boston Transit Commission begins construction of Tremont St. Subway.		1895 - Chicago: Metropolitan West Side Railroad is the first to begin service with trains pulled soley by electric locomotives.
1896	Proxy Battle Ends in control of West End Co. by B.E.R.Y.	August 15, 1896: Boston Transit Commission begins construction of Charlestown Bridge.		
1897	December 9, 1897: B.E.R.Y. leases West End. December 30: Boston Elevated Railway Co. takes control of West End Street Railway Co. on a 25-year lease.	September 1, 1897: First Section of Tremont Street Subway opened. October 1, 1897: Second section of Tremont Street Subway opened.		July 25, 1897 - Schenectedy, N.Y.: Frank Sprague demonstrates first successful use of multiple unit system to pull a six car train.
1898	March, 1898: Alexander Wadsworth Longfellow Jr. selected as architect of elevated stations. April 29, 1898: Elevated plans approved by Mayor of Boston. July 11, 1898: Elevated Plans approved by Mass. Railroad Commission. Sept. 27, 1898: Contract with Carnegie Steel for structural work on Charlestown Bridge.	September 3, 1898: Third section of Tremont Street Subway opened.		April 1898 - Chicago: Sprague puts multiple unit trains into reliable operation on South Side Elevated Railroad, using third rail electric system. 1898 - London: First electric subway train system begins operation in London, England.

	Boston Rapid Transit Boston Elevated Railway and Orange Line	General Transit in Boston	Surface Transit in Other Cities	Rapid Transit in Other Cities
1899	January 23, 1899: First shovelful of earth dug for constructing foundations near Dudley Street. March, 1899: Lincoln Wharf Property acquired and power station installed to meet prospective demands of elevated system. March 30, 1899: First steel structure erected on Charlestown Bridge. November 27, 1899: Charlestown Bridge opened.			1899 - Brooklyn: Brooklyn Elevated Railroad converts to multiple unit third rail electric operation. 1899 - Liverpool, England: Only elevated rapid transit railway constructed in England.
1900	Construction proceeds on Roxbury division of Mainline.	May 5, 1900: Boston Transit Commission begins construction of East Boston Tunnel from Court Street to Maverick. December 24, 1900: Use of horses as motive power for streetcars is discontinued.		1900 - New York: Work begun on electrification of 2nd Avenue Line. First such service in New York City.
1901	February 17, 1901: First experimental train run along Mainline. June 10, 1901, 5:30 a.m.: Elevated service commences on Mainline via the Tremont St. Subway and the Pleasant Street Connector. First use of multiple unit trains in that Subway. August 22, 1901: Atlantic Avenue loop opened for service.	June 8, 1901, 8 p.m.: Last surface car dispatched over outer Tremont Street Subway Tracks.		
1902	September 25, 1902: Acts of 1902, Chapter 534 provide for BERY's use of Washington Street Subway--to be built by Boston Transit Commission.			Janaury 9, 1902 - New York: Electronically powered multiple unit trains put into service on 2nd Avenue Line. 1902 - Berlin: Work begun on first combined subway and elevated system in Berlin.
1903				Spring 1903 - New York: 9th Avenue Line last to be converted to electrical operation.
1904	January 4, 1904: Mass. Board of Railroad Commissioners approves plans for extension of Roxbury Mainline to Forest Hills. September 10, 1904: First train of automatically opening doors put into service.	October 6, 1904: Construction of Washington Street Tunnel begun by Boston Transit Commission. December 30, 1904: East Boston Tunnel opened for surface-car operation.		Oct. 27, 1904 - New York: First portion of IRT subwat opened for public use.

	Boston Rapid Transit Boston Elevated Railway and Orange Line	General Transit in Boston	Surface Transit in Other Cities	Rapid Transit in Other Cities
1905				1905 - Philadelphia: Combination subway/elevated rapid transit system opened for service.
1906	May 2, 1906: Construction begins on Forest Hills extension at Guild Street. August 6, 1906: Last of open vestibule cars replaced with closed types. August 20, 1906: Construction of elevated structure reaches Egleston Square.	August 3, 1906: West Boston Bridge (Longfellow) opened with special reservation for future Cambridge Rapid Transit line.		1906 - Berlin: Berlin authorities begin expansion of combined elevated and subway systems.
1907	1907: Lincoln Wharf Power Station enlarged. Elevated Structure extended to Forest Hills.	June 20, 1907: Construction begun on Lechmere Square Viaduct.		1907 - New York: "Dual System" conferences inaugurated to plan and construct elevated and subway lines in a coordinated fashion.
1908	1908: Egleston Street Station erected. November 30, 1908: Washington Street Tunnel opened for service and connected to Main Line. Operation of rapid transit cars in Tremont Street Subway discontinued. 1908: Work Begun on reconstruction of Dudley Street Station.			1908 - New York: Hudson and Manhattan line with rapid transit tunnel to New Jersey opened for public use. Last horse-drawn Omnibus company--Fifth Avenue Company--ceases operation.
1909	November 22, 1909: Mainline service along Forest Hills extension commenced.	August 12, 1909: BERY begins construction of Cambridge Subway. September 29, 1909: Boston Transit Commission begins construction of Cambridge Subway under Beacon Hill.		
1911		March 8, 1911: Service on the Atlantic Avenue Line cutback to a shuttle train between North and South Stations.		
1912	September 11, 1912: Green Street Station opened for public use. December 9, 1912: Enlarged Dover Street Station opened for public use.	March 23, 1912: Cambridge Subway opens eith service from Harvard Square to Park Street. June 1, 1912: Lechmere Line Viaduct opened to connect Lechmere Station and the Tremont Street Tunnel. November 29, 1912: Construction of East Boston Tunnel Extension to Bowdoin Square begun.		

	Boston Rapid Transit Boston Elevated Railway and Orange Line	General Transit in Boston	Surface Transit in Other Cities	Rapid Transit in Other Cities
1913	January 1, 1913: The name Elevated Division changed to Rapid Transit Lines. March 13, 1913: Seven car train service introduced on Mainline. August 14, 1913: Storage yard and ramp at Arborway opened for storage of rapid transit trains.	October 3, 1913: Entire Boylston Street Subway opened for public use.		1913 - Chicago: All Chicago elevated railroads unified to operate under one management. 1913 - New York: Public Service Commission begins expansion of all elevated lines. Second tier system of express line track construction begun on New York City elevated lines.
1914				
1915		April 4, 1915: Dorchester Street Tunnel opened from Park Street to Washington Street Stations.		
1916	February 5, 1916: Eight car train service introduced on mainline. 1916: New surface car station and connecting bridge to elevated structure constructed at Egleston Square.	March 18, 1916: East Boston Tunnel Extension opened to the public.		
1917	January 20, 1917: Egleston Square Station Street Level opened.			
1918	July 1, 1918: Public control Act goes into effect and control of BERy is turned over to a board of five Trustees.	June 30, 1918: Boston Transit Commission disbanded and replaced by Boston Transit Department.		
1921	January 11, 1921: Construction started on rapid transit train storage yard at Forest Hills.			
1923	March 23, 1923: New storage facilities and repair shop open at Forest Hills.			

APPENDIX B

Copy of Contemporary Description

of Electrical Systems by

Frank J. Sprague, 1901

as Published in

THE ELECTRICAL REVIEW

Dec. 13, 1901 through Dec. 27, 1901

s population of over 6,000,000, and the ... to lay stress on the provision made ... a limited user of the telephone ... deputation that the rates would ...

Administration of the Argen... the advisability of proposing to the ... rence to be held next year in London ... ry of Mr. Nicholson, Superintendent of ... npany. The system was invented in ... at it considerably reduces the time ... e of the vocabulary has appeared in ...

OPEN AND CLOSED.

OPEN.

...mber 18th. Tenders are invited ... of the Colonies for the supply of ...

1st. The municipal authorities ... ders until the March 1st, 1902, for the ... lighting installation. Tenders are to ... to La Collège, Echevinàl, Ghent, ... ined from Le Bureau des Travaux.

Corporation Tramways Committee ... of the following stores for the 12 months ... 2:—Poplar wood blocks; cast-iron ...; motor grease; river sand; cleaning ... brushes.

...th. Electric lighting of Suez ... rom the Minister of Public Works, ...

16th. Estimates will be opened ... France, on 16th prox., for the supply ... pumps, for the purpose of raising water ... ge station; and at the Hotel de Ville ... e date, supply of two electric groups ... Information in each case from the ...

17th. Tenders are being invited ... French Post and Telegraph authorities ... 5 kilometres of iron pipes for pneumatic ... e sent to Le Sous Secretariat d'Etat de ... 103, Rue de Grenelle, Paris, where ...

15th. Pipework and mechanical ... ectricity works for the U.D.C. ... 6th.

17th. Meters (D.C.) and ... ks. See "Official Notices" December ...

8th. Piping, pumps, feed heater, ... ee "Official Notices" to-day.

...ion Electrical Engineer (Mr. J. ... o advertise for tenders for (1) erection ... 0-H.P. water-tube boiler; (3) one set of ... plant; and (4) one dynamo and ... board.

...th. Boilers and economisers, ... ipes, dynamo and feeder panels. See ... 6th.

...th. Electric fire alarm system ... l, Hampstead, for the Metropolitan ... l Notices" November 29th.

...er 13th. Steam piping, trans... attery, switchboard, arc lamps, cable ... ghting works. See "Official Notices" ...

...er 13th. Stoneware conduits for ... &c., for T.C. Consulting engineers ...

19th. Electric light fitting and ... ildings for the Corporation. See ... th.

...r 17th. Tenders are invited for ... and 3 of a subway for electric cables ... ace and Queen Street, Bradford.

... on page 1017.)

SPRAGUE MULTIPLE UNIT SYSTEM.

AS APPLIED ON THE BOSTON ELEVATED RAILWAY.

BY FRANK J. SPRAGUE.

The multiple unit system, reduced to commercial practice in Chicago only four years ago by the writer, is now recognised as the preferable method of operating electric railways on all congested service where there are frequent trains of variable length, and the need is felt of quick and economic handling of units at high schedule speeds. It has received the highest practical endorsement, the adoption already of over ...,000 H.P. of equipment, and it is reasonably safe to say that for the class of service for which it is designed, no other method of train operation can approach it for effectiveness.

The system is really a method of train operation and control, by means of which cars are equipped with motors and motor-controllers, individual to these cars, so that they may be united with any number of other cars similarly equipped, or with any number which have no motors, into a train of any length, and operated from as many points as desired through a controlling line common to all cars. The

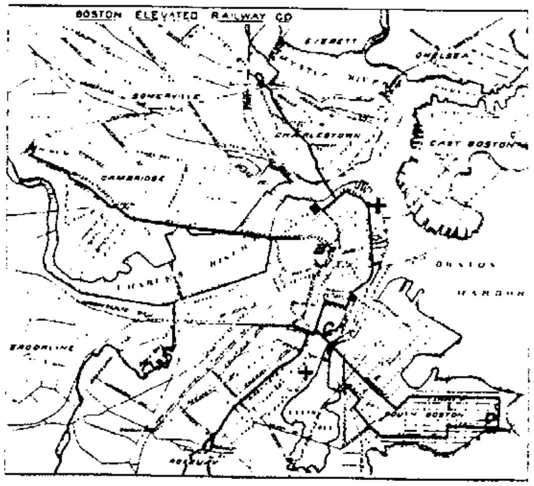

FIG. 1.—MAP OF BOSTON ELEVATED RAILWAY.

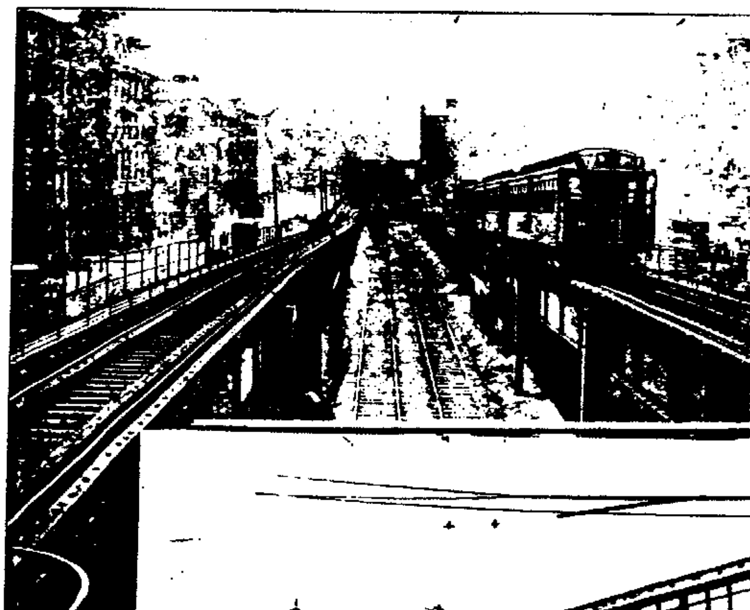

FIG. 2.—THREE-CAR TRAIN ASCENDING 5 PER CENT. GRADIENT FROM SUBWAY.

FIG. 3.—TWO-CAR TRAIN AT CITY SQUARE STATION.

number of cars, their sequence, and their end-to-end relation, are matters of indifference, and the character and capacity of the equipment are dependent upon the schedule specified, varying from every car, where the highest schedule is required, down to two cars in a train.

It is evident that such a system lends itself to every condition of congested passenger service. The similarity of equipment ensures flexibility of train operation, and provides a motive power proportioned to the requirements. Locomotive operations are abolished, trains can be reversed at any cross-over, and traffic concentrated on any section of a road. The safe interval between trains is dependent upon the maximum speed and the power of control, and hence both the time and the distance intervals between trains can be reduced.

With high-power equipments any required schedule up to the maximum becomes possible, and the number of cars in service can be made a minimum. Where a crowded system has main tracks with branches, units for the different branches can be combined on the main line, and split up at junctions, and *vice versa*.

FIG. 4.—SPRAGUE FOLDING CAB.

The operation of the system is simple. Every unit being self-contained, and every aggregation of such being simply an extension in the length of the unit without changing its general character, operation becomes habit. Like hand and like train movements exist whatever the combination of units. Protected by automatic devices, a man of ordinary intelligence can handle trains with less trouble, so far as the electrical apparatus is concerned, and with less instruction than is required for the air brake. The highest safety being essential, the system of operation obviously provides it. In case of failure of brakes, the machines throughout the entire train can be safely reversed. The current input to the machines is automatically limited on each one to its safe capacity. In case of accident to an operator, the entire power is instantly removed from the train, and if the master switch on the leading car is inoperative the train can be operated from either end of any other. In fogs and on slippery rails, a fixed schedule can be maintained more effectively because of the lower maximum speed, and the less distance travelled in braking.

The multiple unit system has now become a necessity, for without it some of the modern railway work would be impossible. In the history of transportation no more difficult problem has been undertaken than the inauguration of the elevated service on the lines of the Boston Elevated Railway. The transportation problem in Boston is most complex. The

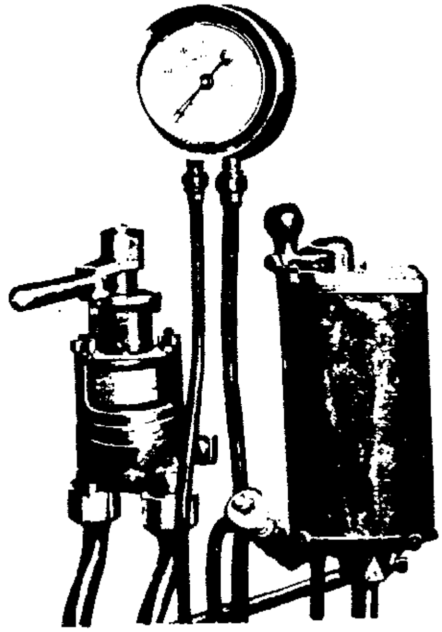

FIG. 5.—MASTER-CONTROLLER, ENGINEER'S VALVE, AND AIR GAUGE.

streets are narrow and crooked, and the inner terminus for most of the travelling public is a restricted area and extremely crowded. The congestion of the car service was considerably removed by the construction of the "Subway," built by the Rapid Transit Commissioners of Boston and leased to the street railway company. This afforded temporary relief, but it was early found to be inadequate for Boston's growing needs.

The necessity for improved service being seen, plans were made and work actively prosecuted—one result being the elevated system shown in the accompanying map (fig. 1)—all of which, except the portions marked A B, crossing the Charles River, and C D, to South Boston, is built and in operation, with about 15 miles of track. Without personal inspection of the road, the boldness of the conception

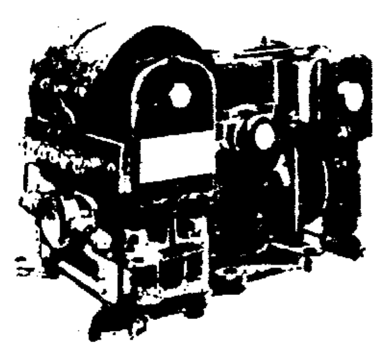

FIG. 7.—PILOT MOTOR DETACHED FROM MAIN CONTROLLER.

can hardly be appreciated. On a trifle over 10 miles of track, the western route alone, there is an aggregate of 3,39[illegible] of curvature, and the longest stretch of straight track is less than ·28 mile. If the track were laid out with this amount

of curvature from a comm
10 circles. Many of the
The ascending grades are
per mile; the descending
mile, or 8 per cent. (fig. 2
Of the present railway

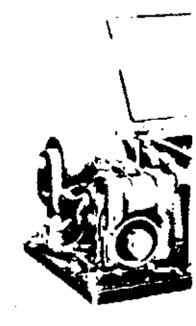

FIG. 6.—M

round in the subway, an
structure at each end of the

OPENING

Surface cars had been run or
the elevated lines since the
make the track connections
reconstruct the subway p
was necessary to discontinue t
the subway. With a view
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Monday morning, June 10
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When this service was undert
of the trainmen had eve
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The extraordinary conditions
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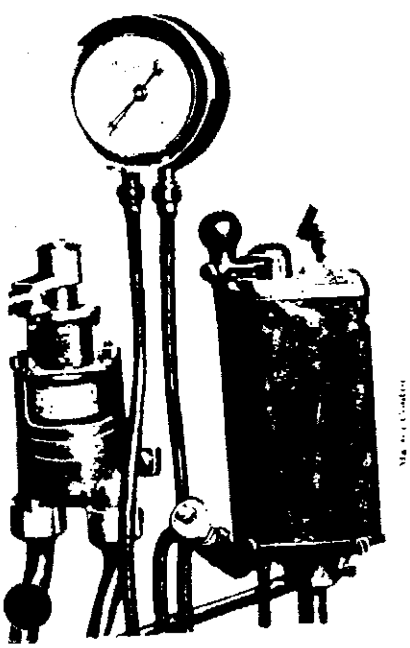

-Master Controller, Engineer's Valve, and Air Gauge.

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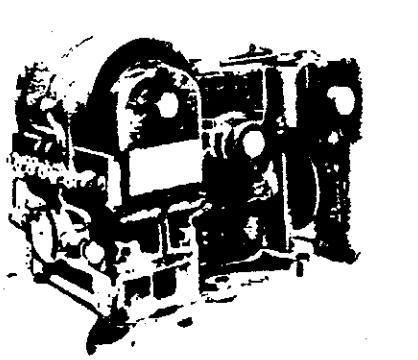


-or Motor Removed from Main Controller

illy be appreciated. On a trifle over 10 miles of the western route alone, there is an aggregate of 3.39 :ature, and the longest stretch of straight track is less :8 mile. If the track were laid out with this amount

curvature from a common centre, it would complete nearly :0 circles. Many of the curves are as low as 90 ft. radius. The ascending grades are as high as 5 per cent., or 264 ft. per mile; the descending grades as much as 422 ft. per mile, or 8 per cent. (fig. 2).

Of the present railway tracks, about 2.27 miles are underground in the subway, and the remainder on elevated structure at each end of the road.

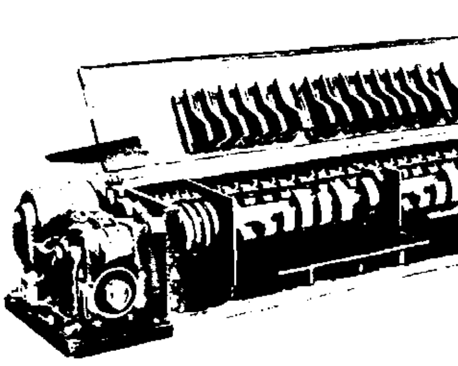


Fig. 6.—Main Controller, Open for Inspection.

Opening of Road.

Surface cars had been run on the subway tracks now occupied by the elevated lines since the subway was opened. In order to make the track connections to the elevated structure, and reconstruct the subway platforms for elevated trains, it was necessary to discontinue the surface cars on the tracks in the subway. With a view to causing as little inconvenience to the public as possible, this change was made during a week-end. On Saturday evening, June 8th, at o'clock, the last surface car was run over these tracks, and Monday morning, June 10th, at 5.30 o'clock, the elevated service was begun. Over 1,200 men were busied during the time in making the change. In addition to perfecting track, signals, platforms and equipment necessary to be used in operation, the largest task in this limited time was to rearrange the operation of the surface lines, and to provide for the changed conditions of traffic. :0 surface cars are run on the Boston system. During the change-over temporary schedules and lines were in operation. This would not have been possible during the middle of the week, as street traffic would not permit the number of cars to be on the streets. The starting of the elevated service required the changing of 51 lines of surface cars and the inauguration of 23 transfer points. [illegible] called for the provision of a new transfer system, requiring the instruction of no less than conductors of the surface lines. Of :0,000 daily passengers, fully 45 per cent. were diverted from their accustomed routes of travel. On their opening day it is estimated that 66 elevated cars carried 300,000 people, and were transferred at the Sullivan Square station.

When this service was undertaken not one of the trainmen had ever made a complete trip over the road, and few ever had any experience with train service. The equipment was entirely new, and last, but not least, majority of the patrons had never ridden on an elevated

The extraordinary conditions surrounding the operation of trains rendered every possible safeguard imperative, so every improvement conducive to safety has been adopted. The guard rails are of 100 lbs. section, and are rigidly fastened. They are placed somewhat higher than the track rail, so that the possibility of derailment is practically eliminated. The strength and rigidity of the structure is exceptional (fig. 3), and the excellence of the details of track alignment and special work is notable. The movement of trains is governed completely by interlocking stations and by automatic block signals of the electro-pneumatic type. One of the track rails is insulated from the other, so that a track circuit signal system can be used. The cars are all provided with automatic trips, so that if a train is run past a stop signal, the air on the train is immediately thrown into "emergency."

The question of control and equipment of the trains was one which called for the most exacting consideration. It was early appreciated that more than the usual motive power should be used. Equipment on more than one car in the train and the "multiple unit" system were considered imperative. In order to determine the safest and best system for their use, it was decided to invite the installation of three different equipments on test trains to be run over the most difficult portion of the road—the subway. The tests and investigations made were the most complete and elaborate ever undertaken in competition for an electric railway equipment. The contract for the controlling system was finally awarded the Sprague Electric Company, and this was followed by two additional contracts, aggregating 150 motor cars, of which 100 are already installed.

For the construction of the cars and the installation of all apparatus on them most careful and exacting specifications were made. The cars are substantial and very solidly built; the seats are longitudinal, and centre doors are used. The platforms are longer than customary. The familiar "Sprague" folding cab (fig. 4) is used for the motorman and operating apparatus. It permits the gates on each side of the platform to be of the same size, and gives free access across the platform. The cars seat 48 passengers; 80 more can comfortably stand up. Both motor and trailer trucks are solidly built and of heavy construction. The motor axles are 6¼ in. diameter at centre with 7½ in. wheel-fits. The wheel base of the motor truck is 6 ft., and the wheels 33 in. in diameter.

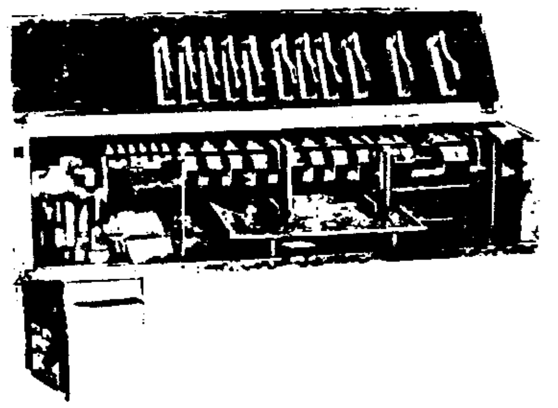


Fig. 8.—Main Reverser, Open for Inspection.

The wheel base of the trailer truck is 5 ft. and the wheels 30 in. in diameter. The wheels are steel-tired, and the gears solid and pressed on the axles. Automatic couplers of extra heavy construction are used. Each car is equipped with two 150-H.P. motors, with side bar suspension. They are rights and lefts, so that the commutators are on the same side to permit of ready inspection.

The air-brake system is that of the Christensen Engineering Company. The motor-driven compressor has a capacity of 20 cubic ft. per minute to a pressure of 90 lbs. The engineer's valves have excess pressure adjustment (fig. 5). The governors are of the equalising type, and control all of the compressors in a train. The cars are heated and lighted electrically.

The multiple-unit control equipment is of the Sprague type. The working apparatus is located in a compartment under a portion of the seat at one side of the car. This compartment is open through the bottom of the car. Complete isolation of working currents from the inside of cars is therefore secured, with all the advantages of ready and efficient inspection which such location ensures. The protection and isolation of the car wiring is a matter to which especial attention has been given. It was realised that the current value of any short circuit would be in excess of any reached in any service existing elsewhere, and that such short circuit might be hazardous. The current is collected from four contact shoes carried on long wooden shoe beams on the trucks, and the main car wiring is led to each shoe through a detachable shoe fuse. The shoe fuse clears any accidental "ground" either on the car or by a contact shoe. From the junction of the contact shoe leads the main wiring extends to a protected compartment in the hood at one end of the car, where the taps are made for lights, heat, air and control apparatus, to the main switch, then back to an enclosed main fuse of the "Noark" type, located under the car; then to the control apparatus and motors.

All of the truck, car and motor wiring is of special high-grade 3,000-volt insulation. It is removed from all vibration as far as possible, and enclosed for mechanical protection. The controller equipment for each car is made up of five component parts:—a main circuit-breaking reverser for determining direction of movement; a main controller for determining speed by variation of resistance and grouping of motors; two master switches connected to switch lines for determining the movement of the main controller and reverser; a secondary controlling train line terminating in couplers at each end of the car; and a reversible jumper for connecting up the train lines on the several cars. In addition there is a set of relays and the throttle. These several parts are shown in the accompanying figures.

Main Controller.

The main controller (fig. 6) is of an "ironclad" type. All cables are led to bolted terminals insulated on slate, and connections are made outside the controller. The main contact segments on the cylinder are provided with removable 1¼-in. copper tips, and each carries only the current of one motor. The contact fingers are screw adjusted, and are provided with springs of substantial design, reinforced by a shunt of leaf copper. The finger bases are cast solid with the terminal studs. The arc deflectors are of reconstructed granite, which combines in a most efficient way high insulation and heat conduction. The control limit contacts and segments are isolated from the main contacts by a vulcabeston partition. All exposed metal surfaces, other than contact surfaces, in the interior of the controller, are covered by insulation, and are finished hard and smooth. The blow-out coil is of simple and substantial construction, of liberal dimensions, and protected from working contacts. Means are provided for adequate ventilation of contacts and coil. The insulations on the shaft are double-keyed, to prevent possible loosening, and are set under pressure.

The pilot-motor (fig. 7), which drives this main controller spindle, is rigidly bolted to the controller base, and is removable as a whole, or the fields can be removed separately. It drives the controller by a stepped movement through a powerful spring and locking pawl. These are of the most efficient design, to ensure "quick make" of contacts, and to secure positive notching. The gears run in an oil chamber. The armature support and shaft are forged from one piece of steel. The pilot-motor armature is so made as to secure rigidity of construction as well as protection of the windings. The commutator is of copper, insulated with mica, and the brushes are of carbon, with automatic feed. All coil terminals are of heavy copper, securely fastened, with means for bolting the connecting wires.

Reverser.

The reverser (fig. 8) is of the same "ironclad" type as the controller. The contact plates, fingers, and finger bases, deflectors, bearings, and blow-out coils are interchangeable with those of the controller. In addition to the motor reversing contacts, the reverser has a muffled double break" isolated by vulcabeston partitions from both the motor and the limit contacts. The reverser coils are wound with a liberal margin above service requirements, and are effective between 300 and 600 volts. The plungers are kept central, and guided by phosphor-bronze rods. The reverser is brought to "open" by a powerful eccentric spring connection, and the link connection to reverser cylinder is constructed so that the reverser is "dead beat" when open. Provision is made for the release of the cylinder from the driving mechanism for the purpose of ready inspection.

(*To be continued.*)

THE ELECTRIC TRAIN CONTROL SYSTEM ON THE GREAT NORTHERN AND CITY RAILWAY.

Electric traction is now being applied on all the new railways in London, and seems destined at no distant date to supersede the steam locomotive on all City and suburban lines. One of the latest lines to adopt electricity as a motive power from the outset is the Great Northern and City Railway, which will run from Finsbury Park to Moorgate Street, a distance of some 3½ miles, with intermediate stops.

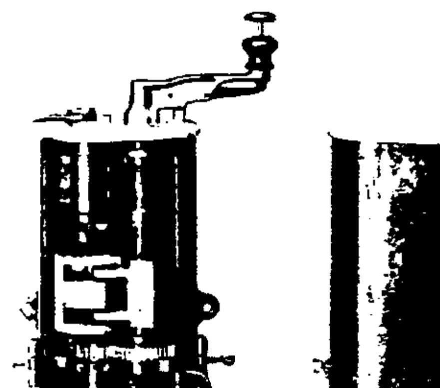


Fig. 1—Master Controller, Open, and Cover.

To deal with the heavy passenger traffic between the City and suburbs on this line, it is necessary to have a rapid and frequent service of trains, and as the stations are comparatively near together it is essential to employ a high rate of acceleration.

Another requirement of the line is that the train must be capable of operation in either direction and from either end, so that time and space required for the shunting of a locomotive at crowded termini may be avoided.

...fter a thorough investigation of th... ...ystems, the Great Northern & City Railw... ...o equip their trains with the master co... ...omson-Houston Company, Limited, ...o meet the above requirements.

The trains will each weigh about 200 t... and will consist of seven coaches in all, ... and two end ones—will each be equipped

The motors, each of which has a rated ... ...e British Thomson-Houston Company's ... ...e latest improvements, including ... ...g the most perfect ventilation. The m... ...re the same as those which have been ... ...levated Railway, of New York, after the ... ...d exhaustive trials of their capabilities. ... ...is system are now in satisfactory operatio... Railway.

The master control system consists in ge... a number of electrically operated switch... ...gulating the series-parallel motor cont... ...fferent combinations of the motors, and ... ...ce in circuit with them, and a separa...

Fig. 5—Connections for Typ...

...verse switch; second, two master controller ...d of each motor car, which operate the moto... ...d reverse switch. A cable connected to ea... ...d to the electrically-operated switches, runs ...e train, whether the cars are motor cars or ... ...itable couplers for connecting the cars.

The synchronous action of the motor contro... ...ith the movement of the master controller b... ...istance connections and motor combinations ks now being erected consist of ›d accumulator room. The boilers are , and are fitted with chain grate stokers ›tors will also be added. Two Belliss ker dynamos are being put down; each ng 135 B.H.P. with a steam pressure of ›n is made for the addition of a larger ery of accumulators is being supplied aving a capacity of 350 ampere-hours ›res. The system adopted is the three- h a pressure of 240 volts at the lamps. by Messrs. Kelvin & James White, of of the cables will be laid by Messrs. tem, and it is hoped that the supply ary. The whole of the work is being Electric Supply Company, under the engineer, Mr. W. E. Milne. Messrs. tors.

ime ago the Tramways Committee o the E.L. Committee for a reduction of d to them for tramway purposes. Mr. r, drew up a report showing the charges st week it was decided that the Com- price of 2d. per unit now charged. The ›ittee had lost considerably last year on ›t for electricity for the trams being ›e charge only 2.33d.

roceedings of the District Council ›llivan's operas, or of the story of Briefly, the E.L. Committee elected a chairman, knowing that Mr. Shaw was e latter then presided at a meeting of t against the Council's electric light mmittee passed a resolution of want of goed, and afterwards tried to get the ›ected, but without success.

men, electrical engineer to the had been called in to report on the pre- ›st of lighting the docks, reported that ling maintenance, was 1.577d. per unit. e generation of electricity at the docks ration at 1d. per unit, provided it was 300,000 units per annum. With main- ressed the opinion that 1½d. per unit ould be done for, and probably it would › offer the Harbour Trust the necessary › a minimum quantity of 300,000 units

ting of the T.C. last week the town › the sanction of the Local Government £11,000 for electric lighting purposes. clerk of works, for the erection of the , it was decided to select three or more the Committee, and after the interview , was appointed at a salary of £3 3s. per he construction of the tramways was e to confer with the electrical engineers report.

lebury.—The U.D.C. has appointed g engineer to the Council.

›rporation has deferred consideration eme for six months.

The T.C. has decided to apply to the loan for establishing electric lighting

ectric light receipts for the September d. After meeting the cost of production st and sinking fund, there was a surplus ›rter. There are now 568 customers with ›y of electricity sold was 100,967 units.

TRACTION NOTES.

h delivered by the Italian Premier, last, he stated that as soon as the Chamber without having recourse to private con- Naples electric railway project before the project stipulates for the accomplishment e two cities in 2½ hours.

trial of the high-speed electric railway e was made and a speed of 90 kilometres ›ained. The train was composed of two ›.

dvent of the L.U.T. trams in this of waking up the local shopkeepers on the om are putting in new fronts and other- ›r popular patronage.

(Continued on page 1049.)

SPRAGUE MULTIPLE UNIT SYSTEM.

As Applied on the Boston Elevated Railway.

By FRANK J. SPRAGUE.

(*Continued from page 972.*)

Master Switch.

The master switch (fig. 10) is of the cylinder type. Right and left movement of a single detachable handle, normally

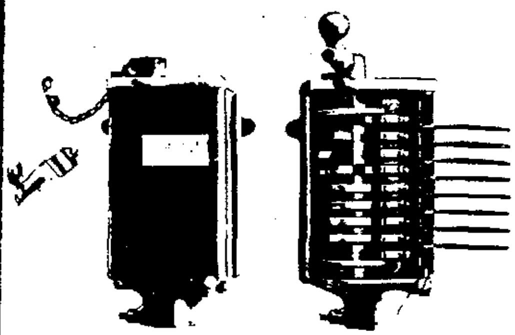


Fig. 10.

latched in a central position, produces ahead and reverse motion, and any desired variation of speed. Movement is opposed by a spring, which returns the handle to the central or "off" position when released, and automatically cuts off the main current. The cover is lined with mica, well lacquered, and is easily removable. The vulcabeston separators are hinged to facilitate inspection. The switch is of such form and dimensions as not to restrict in any way the clear passageway across the car platform.

Train Line Coupler and Jumper.

The train line is a compound cable, each wire heavily insulated and tested at 4,000 volts, and the whole sheathed with a waterproof braid. The couplers (fig. 11) are iron shells enclosing a block of insulating material, which supports the split-spring terminals of the train wires. They are connected to the train line at junction boxes. The terminals are

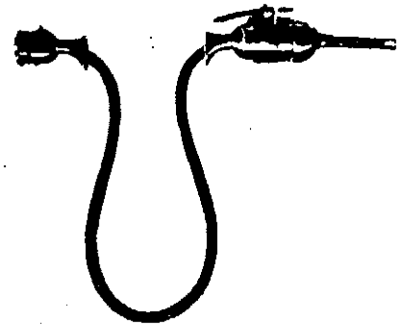


Fig. 11.

separated by an insulating partition, and are well insulated. The couplers are shrouded, and are self-closing when not in use. The jumper, whose ends are constructed in a similar manner to the couplers, and have complementary female contacts, is reversible, and can be coupled in one plane only. Both the jumper and the coupler are connected to the cables permanently at the back, the intervening spaces being filled with insulating compound. Each conductor is insulated with rubber, and protected with braid of various colours to facilitate connections.

Relays, Automatic Stop, and Throttle.

The relays, automatic stop, and throttle (fig. 12) are mounted vertically upon a slate support, thoroughly insulated, and the contacts are well separated and rigidly secured. The coils are held firmly in place, and the plungers are positively guided. Platinum or silver tips are used for the throttle in order to require minimum attention and to ensure perfect contact. The bridging discs have universal adjustment and spring cushion. The protective fuses for the control circuits are carried by clips on the relay slate, which also carries for convenience the cut-out switches and part of the adjusting resistances.

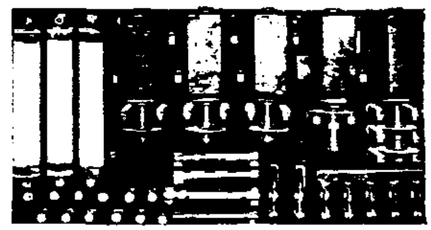


Fig. 12.

Resistances.

The grid resistances (fig. 13) for the main motors are of a special cast material, and are of a loop form to ensure flexibility. They are supported in longitudinal vertical planes on reconstructed granite insulators carried by angle irons for attachment to the car. Their construction permits of easy installation and repair, and secures reliable insulation as well as efficient radiation.

They are of sufficient section to withstand the shocks of service, and are of ample carrying capacity for the most extreme demands. All wire connections are made by means of bolted terminals.

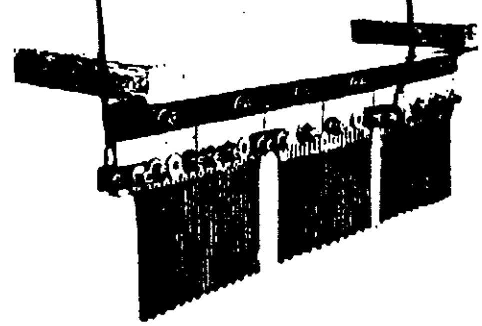


Fig. 13.

Weights of Equipments.

These are as follows:—

	lbs.
Two master controllers	45
One set relays, fuses, switches, &c.	96
One main controller and pilot motor	570
One reverser	560
Two junction boxes	6
Two couplers, with attached cables	25
One jumper	10
One set of grid resistances	660
One set of master switch and train cables	50
Total	1,972

OPERATION.

In the Boston equipment the motor switch is a separate piece of apparatus, operated when the rheostat switch is in an open circuit position, but for convenience of illustration

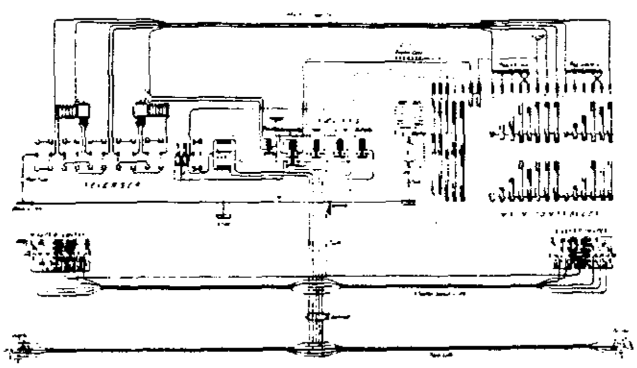


FIG. 14.

and description it may be shown on the same cylinder as the rheostat. The typical circuits are arranged as shown in fig. 14, in which the various parts of a full equipment are indicated, as well as the inter-connection of circuits.

In ordinary operation the main motors are first thrown into series with a resistance, which is cut out until half the pressure is supplied to each motor, which is the half-speed combination. In going thence to full speed, the main circuits are first opened instantly at the main controller or reverser, or, if desired, progressively through resistances and independent main contacts. The motors are then thrown into parallel, with a resistance in circuit of about one-quarter that used in the first series position, which is progressively cut out until the motors have full pressure, and run at their full capacity and speed. The quartering of the resistances on the first position is effected by using independent resistances for each motor, throwing them in series and parallel relation the same as the motors and using the same progressive steps.

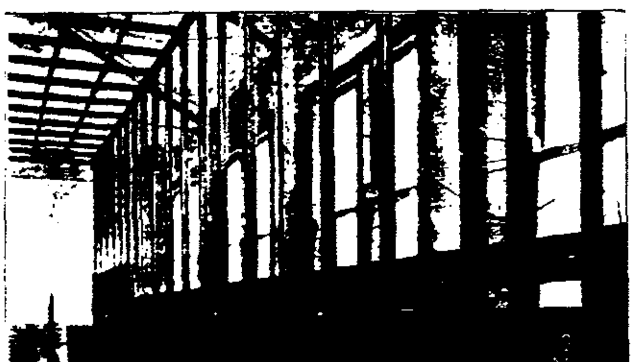
In any position of the controller the current can be cut off instantly by the reverser, which has also independent main-line contacts on the same spindle. Provision is made for dead-beat movement, and also for inter-connection of controlling circuits by contacts on the same cylinder as the main contacts. The circuit for the reverser passes through the automatic stop coil, and is completed through a by-pass on the controller in the first contact position, or through a contact made by the automatic, so that once opened it cannot be operated again unless the controller is in a safe position for the motors.

The cylinder of the main controller is driven with an intermittent motion by a pilot motor through a powerful locked spring, so that the armature of the pilot motor and the spindle of the cylinder do not move either in synchronism, or to an exactly like extent. This is necessary to ensure freedom from hot contacts and dragging of arcs.

The pilot motor is governed by five relays, called, respectively, the "coast," "series," and "multiple" relays, the "automatic stop" and the "throttle."

There are three ordinary running positions for a pair of railway motors: the coast or open circuit position, the series position, when the two motors are in series without any resistance in circuit, and the parallel position, when the two motors are independently across the line without any resistance. In addition, the motors can be run temporarily with more or less of the resistances in circuit for the purpose of switching. On heavy railroad work, such as on elevated and suburban roads, minor variation of running speed in either the series or multiple relation of the motors by the use of resistances is rarely practised, and is never necessary, save in starting. The apparatus is especially arranged to discourage any such variation of running speed.

The circuit which operates the pilot motor on each car is a purely local circuit, coming from the car shoes and returning to the track, just as the main circuit of the motor does. It is not connected to the train line or the master switches in any way. Its path is through the field magnets, brake and armature of the pilot motor, through the contacts of the coast, series, or multiple relays, and also through the contacts of the throttle and automatic stop. If either the throttle or the automatic is in an open circuit position, it is impossible for the pilot motor to move in one direction, and hence impossible for the controller to be advanced, although if in the advanced position it can be reversed. The circuits through the relay contacts and the pilot motor also pass through limit switches on the controller cylinder. If this control cylinder is in the "off" position, and the throttle and automatic stop are in the proper position, closing the coasting relay will not cause any movement whatever. but closing the series relay will allow the pilot, if otherwise uninterrupted, to move the controller to the series position, where it will automatically stop. In the same way closing the multiple relay will move the controller either from the coast or series position to full parallel, where it will be automatically stopped. Opening the throttle, however, will either arrest or retard the rotation of the pilot motor and the progression of the controller, and dropping



THE CENTRAL TELEPHONE EXCHANGE.—VIEW OF METER BACK.

the automatic by opening the reverser circui the controller to open circuit or any oth position, regardless of the motorman.

The throttle is operated automatically by : one of the motors, and serves a double purpos or stops the forward movement of the main co desired current increment, and since it respo mined value of the current, it can become an aut for providing a definite rate of acceleration, prevent any desired slower rate of accelerati way remove from the motorman the possi main controller at will within the limits of safe current input.

The coast series and parallel relays are ener form-switch circuits, which terminate in the n To this switch are brought also the terminal solenoids operating the reverser. Except as t is limited by the automatic features. or hinder stances which he cannot, and is not intended t operation either of the particular car or the trai at the master switch.

(*To be continued.*)

THE CENTRAL EXCHANGE OF THE POST OFFICE TELEPHONE

(*Continued from page* 987.)

WE may now proceed to describe the connecti system of working.

At the subscribers' station there is a ma receiver and induction coil, a transmitter, a condenser. The connections of these are shown ing diagram. It will be seen that when the recei hook, the receiver and transmitter are cut o and the subscriber's circuit is open to direct cur lines are, however, bridged by the magneto-b

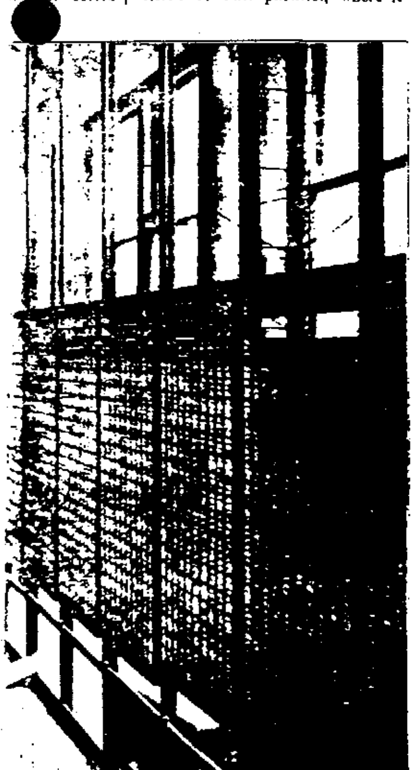
BACK VIEW OF LOCAL BOARD, UNDER CONSTR

with the condenser; consequently the circuit is alternating currents, and thus the subscriber ca from the exchange.

Following the lines to the exchange, we constant potential difference of 20 volts is maint them by means of a storage battery. When th takes his receiver from the hook, his speakin

In addition, the motors can be run temporarily ...r less of the resistances in circuit for the purpose ... On heavy railroad work, such as on elevated an roads, minor variation of running speed in either the series or multiple relation of the motors by the use of resistances is rarely practised, and is never necessary, save in starting. The apparatus is especially arranged to discourage any such variation of running speed.

The circuit which operates the pilot motor on each car is a purely local circuit, coming from the car shoes and returning to the track, just as the main circuit of the motor does. It is not connected to the train line or the master switches in any way. Its path is through the field magnets, brake and armature of the pilot motor, through the contacts of the coast, series, or multiple relays, and also through the contacts of the throttle and automatic stop. If either the throttle or the automatic is in an open circuit position, it is impossible for the pilot motor to move in one direction, and hence impossible for the controller to be advanced. ...n the advanced position it can be reversed. The ...ugh the relay contacts and the pilot motor ...rough limit switches on the controller cylinder. ...trol cylinder is in the "off" position, and the ...automatic stop are in the proper position, closing ... relay will not cause any movement what... ...losing the series relay will allow the pilot, if ...interrupted, to move the controller to the series ...ere it will automatically stop. In the same way ...multiple relay will move the controller either ...st or series position to full parallel, where it



... Exchange.—View of Meter Rack.

...matically stopped. Opening the throttle, how... ...ther arrest or retard the rotation of the pilot ... the progression of the controller, and dropping

the automatic by opening the reverser circuit will return the controller to open circuit or any other determined position, regardless of the motorman.

The throttle is operated automatically by the current in one of the motors, and serves a double purpose. It retards or stops the forward movement of the main controller at any desired current increment, and since it responds to a determined value of the current, it can become an automatic switch for providing a definite rate of acceleration. It does not prevent any desired slower rate of acceleration, or in any way remove from the motorman the positive operation of the main controller at will within the limits of safe and desirable current input.

The coast series and parallel relays are energised by platform-switch circuits, which terminate in the master switch. To this switch are brought also the terminal wires of the solenoids operating the reverser. Except as the motorman is limited by the automatic features, or hindered by circumstances which he cannot, and is not intended to control, all operation either of the particular car or the train is initiated at the master switch.

(*To be continued.*)

THE CENTRAL EXCHANGE OF THE LONDON POST OFFICE TELEPHONES.

(*Continued from page 937.*)

We may now proceed to describe the connections and the system of working.

At the subscribers' station there is a magneto-bell, a receiver and induction coil, a transmitter, and a 2-mfd. condenser. The connections of these are shown in the adjoining diagram. It will be seen that when the receiver is on the hook, the receiver and transmitter are cut out of circuit, and the subscriber's circuit is open to direct currents. The lines are, however, bridged by the magneto-bell in series

Back View of Local Board, under Construction.

with the condenser; consequently the circuit is complete for alternating currents, and thus the subscriber can be rung up from the exchange.

Following the lines to the exchange, we see that a constant potential difference of 20 volts is maintained between them by means of a storage battery. When the subscriber takes his receiver from the hook, his speaking circuits are closed by the switch-hook, allowing a current to flow through the transmitter and the primary of the induction coil; the small shunt current through the receiver, the secondary coil, and the magneto bell is negligible.

At the exchange, this current passes to one of the lines through the line relay, of 60ω resistance; this switches on the line indicator calling lamp across a pressure of 24 volts, causing

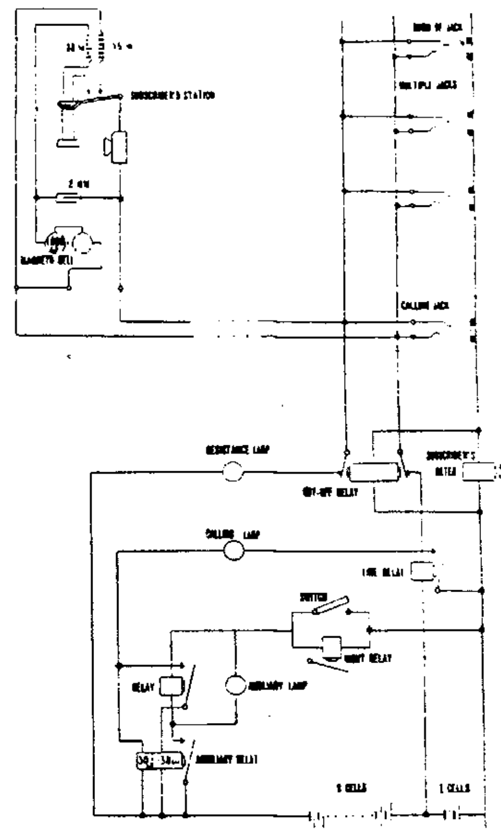


Diagram of Connections Between Subscribers' Station and Exchange.

it to light up, so as to attract the attention of the operator. A lamp of 60ω resistance is inserted in series with the other line; its functions will be dealt with later.

The indicator lamp is directly under the jack allotted to the subscriber who is calling. Hence, the operator has no need to recognise a number as in the older methods, and to find the corresponding jack some inches or feet away; in fact, she does not require even to know the number of the calling subscriber.

Inserting an answering plug into the jack indicated (whereupon the calling lamp goes out), and pressing forward a switch on the keyboard, the operator is at once in communication with the subscriber, ascertains the number wanted, and proceeds to make the desired connection.

For this purpose she takes up the calling plug corresponding with the answering plug just used, and taps the brass bush of the wanted subscriber's jack, with the tip of the plug. If she hears a click in her receiver, she knows that the subscriber's line is engaged, and informs the calling subscriber of the fact. If silence reigns, however, she pushes home the plug, and pulls over the switch previously used to speak to the caller. The first operation causes a lamp to glow, and the second rings the bell of the subscriber wanted. Directly he lifts his receiver his "clearing lamp" goes out, acquainting the operator with the fact that the subscribers are connected. She then presses a button, which registers one call on her own meter and on that of the caller. When the two sub-

ctremely low flat rate. Take
consumer, in his tenth hour
pay 1·6d. per unit by the
although Mr. Wright's own
uires 1·36d. As the produc-
. and the total cost (including
1·22d., he still pays a certain
l-by charges. If, however, he is
e latter, then at 1d. per unit he
ery penny representing ¾d. costs
ppens that one London supply
rate and 4d. after for the hours
d. per unit on a flat rate for the
urpose) during the hours of day-
bt, the 4d. rate will be halved,
l. initial, and 2d. follow-on, will
d hours of darkness, and 2d.
uring daylight hours, which
r. Wright's "ideal" tariff,
meters, one for the "day"
ght" supply, with a single
with the latter, the consumer can
nd dear supplies compare. It is
ay change-over switch, with an
rated by hand, may throw one or
into circuit; or if the meters of
Vulcan type be in use, a clock
the shunt circuit of that meter
ster, the main coils of the two
In the latter case, however, the
d the top or greatest maximum
erely that of the load registered
l which must have occurred at a

and their Prevention.—At a
nd Counties Institute of Engineers,
Derby, a paper by Mr. L. W. de Grave
Some Electric Accidents, and the
was read. The author divided acci-
k" and "fire." Accidents from fire
its, and (b) bad contacts. In enlarging
, the writer stated that it might be
m, air, or rope power, that a plant,
and maintained, was perfectly safe,
. He then dealt with the technical
construction, and the proper provision of
nsulation of wires were suggested, and
r method of artificial respiration for
ons. Mr. Deacon said that he found
workmen against electric accidents in
res underground, in a puddled-clay
to allow traffic over them without
observed that the Paris police were
method of restoring electrocuted
eplied to the remarks that had
ible was, in his opinion, the best
many years without having known a
's suggestion of burying the wires in
a very good one; he had used it him-
admirably. India-rubber gloves be
en if they contained a pin-hole they
uch so, in fact, as if the wearer had an
l. In one works he knew of, where gloves
pair was before being used always sub-
t. There was the additional drawback,
"all thumbs." It followed that the
eloped would not experience the same
to the muscular system. He cited the
shock and lived for only 10 minutes
cial respiration. The coroner's verdict
shock. As a matter of fact, the de-
pure and simple, the attendants having
ne, which had become contracted and
discussion on the paper was adjourned

SPRAGUE MULTIPLE UNIT SYSTEM.

As Applied on the Boston Elevated Railway.

By FRANK J. SPRAGUE.

(*Concluded from page 1047.*)

The master switch has (1) the off or normal position, to which the handle is spring-retracted in case the operator lets go of it; (2) for ahead movement, three running positions, coast, series and multiple or full speed, with no contacts between; and (3) for the backward movement, two running positions, coast and series or half-speed position. The car can be stopped and reversed by a single throw of the handle of the master switch from one side of the open position to the other.

Ordinarily, when a motorman wishes to go ahead at half speed he moves the master switch to the series position. The reverser is instantly set for movement ahead, the series relay is closed, the pilot motor starts up, the driving spring is put under tension, and the controller spindle moves forward intermittently until the pilot limits stop it at the half speed position. If, during this operation, the throttle should lift, this advance of the controller cylinder will be retarded or stopped. If the automatic stop should drop, the advance not only will be stopped, but the controller will at once run backward to an open circuit or other determined position without regard to the set of the series relay, or the wish of the man at the master switch.

Being at the series position, if the motorman wishes to go at full speed, the handle of the master switch is moved to that position, when similar operations take place at the relays and pilot motor; or the operator may move his switch handle at once from the open circuit to multiple, without regard to series, and the main controller, controlled by the throttle, will advance to full speed position. Of course, the advance of the main controller may be made at will, step by step, by touch-and-go contact at the master switch, and its advance can be arrested instantly. If desirable, when a coast relay is used, its connection can be changed so as to, at will, throw the throttle out of action, although this is not desirable.

Comparison of the movements of the master switch and the main controller illustrates very clearly the inter-connection of controlling circuits and their utility, and how they are intended to provide for every emergency whatever. To all apparent intents and purposes the controller seems possessed of an independent intelligence, because the relay system and the interconnection are such that all local emergencies are provided for, as they must be, without regard to the wishes, intents, or carelessness of an operator.

The description thus far is that of the operation of a single car. To connect two or more cars together, and to provide for the initiation of the operation of the controllers on such other cars as may be fully equipped from one or more of the master switches, as well as to transmit control through cars not equipped with motors, the independent train line is provided, which is the extension of the platform-switch circuit from car to car, through fixed train cables on each, terminating in couplers at the ends of the cars, and flexible and reversible train cables, or jumpers, terminating in couplers with complementary contacts, and serving to join the several train cables together at the ends of the cars. These train lines and jumpers are so connected to the coupling heads that the controlling circuits are automatically paired to ensure proper operation of the various main controllers for any master switch without regard to what are the abutting ends of the cars, their number or sequence, or how the jumpers are reversed, or whether, as in practice, they are coupled indifferently on one side or other on the cars.

While some roads only change sequence of cars in the make-up of trains, in many they are reversed, as in the operation of open-end relays, cross-overs, loops and yards. Therefore, in addition to general pairing of the sets of speed and direction circuits, the individual speed circuits must always be paired alike, while the individual direction circuits must at times be changed in connection. Provision is made so that local circuits can be cut off from the train line and independently tested.

Normally, then, movement of any master switch (the others for the time being inoperative and held at open circuit) closes like relays on each car and starts the sequence of operations indicated for a single car, but here also the automatic variation of movement described in regard to a particular controller takes place independently at each car, and different kinds and degrees of movements of the controllers of different cars can take place simultaneously if necessary. Not only that, but to provide for difference of wheel diameters, difference of tractive coefficients on different wheels, and to provide also against any irregular condition on any car, similar movements may be differently timed, and different controllers may take different relative positions when measured by time, each accommodating itself to the limited current input determined for itself.

It therefore becomes possible by this combination of positive and semi-automatic control to combine cars having controllers of different sizes, motors of different capacities, resistances of different gradations, gears of different ratios, and wheels of different diameters, and to safely operate them all from one or more controlling points, all of which, of course, would be absolutely impossible to a hand-method of control, or anything approaching to it.

Current Supply.

Current for the Boston Elevated service is delivered from the stations as follows:—

Stations.	Maximum capacity. Amperes.	Circ. mils. elevated feeders.	Feet to elevated structure.
Central	40,350	8,000,000	800
East Cambridge ...	7,650	6,000,000	5,000
Charlestown	4,350	4,000,000	1,000
Lincoln	21,150	20,000,000	200

Reference to this table will show the possibility of current flow which would follow a short circuit on the elevated lines. By reason of the grades and alignment of the system, and the high speed and frequent service maintained, the fluctuations of load are severe. As the stations feed both elevated and surface lines, the fluctuations due to the elevated service are taken care of without difficulty. Observations so far made indicate that the current demand for a section of the elevated line 1½ miles long, having in operation nine trains, varies from 500 to 6,000 amperes. Even with such demands for current the minimum voltage at the contact rail is 500 volts, because of the large section of feeders and the proximity of the power stations. The feeders used are of 2,000,000 circ. mils. section, and are run in conduit to the structure, where bare tin-copper cables mounted on glass insulators are used. They are covered by a cable box, the top of which forms a convenient walk on the structure. The several sections of the contact rail are tied together by enclosed feeders of 2,400 amperes capacity.

Some of the elevated and surface line sections are fed from two or more separate stations. This ties the stations together, and distributes heavy pulls among the different stations. To further assist in this distribution of "pulls," the generators are given a drooping characteristic. Thus, when an extremely heavy pull occurs in close proximity to one station its voltage falls, and the other stations assist in carrying it. In addition, if any station by reason of locally heavy traffic is overloaded, a portion of its load is shifted to other stations by voltage reduction at the generators by the field rheostats. The feeder system is carefully laid out so that any section may be cut out without interfering with the operation of the rest of the system. In order to prevent the contact shoes bridging from a live section to one in trouble, a rail of suitable length fed through permanent resistance is inserted between the two sections. Specially designed "protected" rail-bonds are in use for feeder taps to the contact rail. The track is bonded to the structure to provide an efficient return circuit.

The Lincoln power station is the one most recently built. It is thoroughly modern in every respect. Vertical engines direct connected to generators of 2,700 KW. normal capacity are used (see fig. 15). The ultimate rated capacity of this station will be 18,900 KW., with ability to carry for one hour 28,000 KW., and for brief periods 38,000 KW. During acceleration each car, which weighs empty 59,000 lbs., and has 63½ per cent. of the weight on the drivers, takes a maximum of 550 amperes, and an acceleration of 1·8 miles per hour per second is obtained. The maximum speed reached between stations is 46 miles per hour. The acceleration is uniform, and the track is of such excellent construction that it is most difficult to realise the high speeds that are obtained.

As near as has been determined, the energy consumption per car-mile is 4·5 KW.-hours. The present mileage is about 20,000 car-miles per day. The grades encountered and the high speeds run are reflected strikingly in the extreme wear of the brake-shoes and wheels. The shoes first used were completely worn out after 200 miles of service. Special shoes are now used, and longer service is secured. This also means exceptional wear on the wheel tires.

One run, that from the Boylston Street (Subway) station, also well illustrates the difficult character of the service. From this station descent is made down an 8 per cent. grade

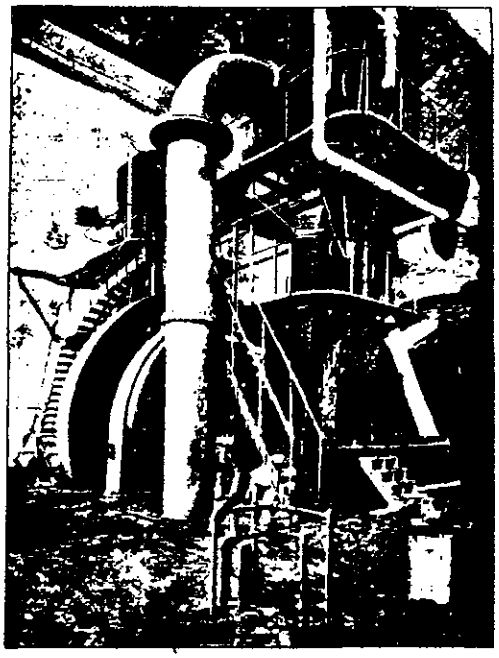


Fig. 15.—2,700-KW. Steam Dynamo.

round a sharp reverse curve without connecting tangent, round other curves and over a changing grade, ascending 4·5 per cent., descending 3 per cent., ascending 2·9 per cent., descending 3 per cent., ascending 5 per cent., then finally descending 1·5 per cent. to the Pleasant Street station, located just outside the subway, at the foot of the incline to the elevated structure.

The passenger traffic is especially complex, because of the system of transfers. At one station these are issued to no less than 37 lines of surface roads radiating throughout the city. At the northerly terminus connection is made with 16 lines of surface cars running to the suburbs, and here as many as 24,000 passengers in an hour, and 125,000 in a day, have been transferred. At the southern terminus connection is made with 34 lines of surface cars, and there is here also a heavy transfer of passengers.

These brief statements will indicate the extreme density of traffic over the whole line, and how imperative are the appointments for the safe and rapid handling of the service. Not the least important are the platform arrangements necessary to care for such traffic. At the terminals, and also at the busy stations in the subway, free access on the same level is given between elevated and surface cars. At other points ticket transfers are issued to and from the street. The traffic has so far exceeded all expectations that both the platform gates and centre doors are used at all stations. On each platform opposite the car entrance is painted "Enter here," to ensure the prompt loading of passengers. By printed notices in the cars and signs at stations passengers are requested to leave the cars at the centre door and enter at the gates. At each station the trains are rung off by a large gong. The gates are then shut immediately, and the station stops are thus reduced. There has been a most marked development in the alacrity which the patrons of the road have attained in entering and leaving trains, and the positive manner in which the gates are shut on signal has much to do with this. The smoothness of operation, and the speed of the trains, have served to make the service very popular.

Plans are being made for the extension of the elevated structure and for the construction of an additional subway. The future will doubtless see no less than 50 miles of elevated track and 600 cars in operation.

The equipment and operation of this system in its entirety is of the most advanced type, and reflects the highest credit upon the officers and engineers of Boston Elevated, who have had for solution a problem of unprecedented difficulty.

THE TESTING AND MANAGEMENT OF ELECTRIC MOTORS.

By P. T. White, Wigan Electricity Works.

It has always appeared to the writer a matter of deep regret that persons of an ultra-mathematical, but otherwise well-meaning disposition, should endeavour to befog the simplest operations of central station testing with involved algebraic formulæ. "Figures can be made to prove anything," especially when one can introduce those God-sends of the "mixed" mathematician—constants—often, alas! of a home-built and rectifying nature.

Of such, I am assured, are the formulæ :—

$$C = \frac{\sqrt{E^2 - 4\,(W + w)\,r}}{2\,r}$$

$$\text{Per cent. efficiency} = \frac{100\,W}{E\,(C + C_f)},$$

and the methods of testing appearing in a recent issue, as an abstract from an American contemporary, under the heading "Electric Motor Testing without a Dynamometer." The efficiency of the machine considered is stated as 86·037. It is a pity that the result was followed to three places of decimals only. In my opinion it should have been pursued to the bitter end—or a "repeater."

Although it is now many years since I left the *calculus* behind me, and even now I seldom employ algebra in my everyday calculations, I have little hesitation in stating that the efficiency of that motor is nearer 88 per cent.

The best method of testing an electric motor is to put an artificial load upon it, and determine the mechanical torque of its armature as expressed in the output of a driven machine whose dynamic efficiency has been found by some common-sense method. In the article referred to we were asked, among other things, to secure the armature shaft, and connect the brushes to the circuit through a resistance, so carefully adjusted, that a D.P. of 220 volts was toned down to ½ volt. Then, with

$$(E - v)\,C_1$$

we got the armature core and friction losses in watts. After both these feats, and the first is no small one, I thought I had "arrived," but my hopes were dashed to the ground, so to speak, when I read "the formulæ for full load current are based upon the assumption that the core losses, armature friction, windage, and pole-piece eddy current losses all remain constant from no load to full load. While this is not strictly true, the error introduced is practically negligible." Certainly; but had it not been so negligible, he might have had to introduce a few more decimals into his computations. In passing, may I commend some similar method to the gentlemen who write you re their coal consumption per unit of output.

As already stated the "artificial load"
the best, and the one most generally em
testing tank is employed, the greatest care
no instance, and the writer speaks from p
should such a test be left in the charge
foolish man. Even when the dynamo sid
tion is properly equipped with cut-outs o
care is necessary. When it is not, disaste
some so-called tests witnessed by the write
deemed necessary to put an ammeter in
meter had, however, been put across the
and the operator was somewhat distressed
minutes from the start his volts began to
came to the conclusion that this was due to
and went forth in search of some resin,
the armature of a valuable machine burnt
be too strongly impressed upon the man wl
of testing for the first time that an ammet
outs are absolutely necessary. It will pay
equipped testing board even when very litt
A method, even better than the "pond
station lighting and power circuits.
usually made up on a board in such a ma
be transferred from one side to the othe
system to assist in maintaining the balanc
be assumed that all motor-testing operation
during the daytime, when the station c
employed for the purpose. Where the st
or in course of erection, it will pay eng
board which will meet these special requi
where the station is completed, methods c
at trifling cost, will readily commend them
men. In small stations where the numb
tested is very small, it will pay to make up
of arcs, incandescents, and the shunts
Whenever it is possible, it would be
testing of apparatus furnishing the load
Meters, for instance, which, in some
properly tested (too much reliance being
maker's test scrip), can be included in the
An important adjunct of any station wi
power load is a small alternator of, say, 15
a terminal voltage of 2,000 or 3,000.
this, it will be easy for an engineer to reje
before expense has been incurred upon t
alternating between windings and frame
light—in more ways than one—the wea
machine. Of course it is evident that sev
be submitted to this test at the same time
This brings me to the discussion of a
testing motors, and one which I should wi
me. With the help of a short countersha
sizes of pulleys to suit the varying spee
different motors, the alternator can also
furnish a load of incandescent lamps t
transformer. I see no reason why the re
not be the station lighting load, though
many engineers will rise in arms against th
of both systems would be the same, or ne
even if they "clashed"—and with prope
should not occur—nothing more serious
would result. Of course it will be unde
cut-outs only, and not circuit breakers, ar
There is, however, the rather remote dar
tension primary invading the secondary
transformer breakdown; but even if thi
trouble would only be momentary. Th
motor fuses would instantly go. There i
the minds of many station engineers wh
alternating currents is limited, and whose
use of same nil, a decided prejudice agai
ment. This may be attributed to their
from shock. Naturally, where high pote
employed, the greatest care must be
"getting into" the circuit. There cann
nowadays safeguards are adopted which,
prevent the recurrence of the many fatali
the progress of the industry in its early day
as high potential is generally inaccessib
criminally negligent, but in the old days t

APPENDIX C

List of Historical Photographs

The following Historical Photographs are taken from the photographic collections of the following public and private organizations:

Bostonian Society, Boston, Mass. (Boston Society)

Boston Public Library (Boston Pub. Lib.)

Boston Street Railroad Society - Library (BSRA)

Carpenter Center, Harvard University, Cambridge, Mass. (Carp. Center)

Library, Massachusetts Bay Transportration Authority, Boston, Mass. (MBTA)

Society for the Preservation of New England Antiquities (SPNEA)

Certain photographs are borrowed from the collections of private individuals who in most cases prefer to remain anonymous.

The present collection of glassplate negatives at the Carpenter Center at Harvard University includes most of the construction progress photographs taken during the construction of the Forest Hills extension. While the Boston Transit Commission and the BERy both took extensive photographs during construction of the different segments of the Boston Transit system, only scattered remnants of the first section survive. Fortunately the Carpenter Center has preserved largely intact the documentation of the Main Line from Dudley to Forest Hills from 1905 to 1912. The MBTA library has a partial collection of photographs documenting the construction of the Roxbury Division. Many of these photographs are reproduced in this study not only to document the elevated structure when it was at its pristine best, but also to serve as a fascinating history of heavy steel construction methods for that early time.

(Note: Sometime in late 1986 the Carpenter Center collection of glass plate negatives was transferred to the library of the SPNEA.)

List of Historical Photographs

Fig. No.	Description	Date	Orig. No.	Source
HP1	Omnibus and Horse Drawn Streetcar on Washington Street.	July 8, 1889	-	Boston. Society
HP2	Horse drawn Streetcars - Tremont Street.	1890	-	Boston. Society
HP3	Electric Streetcars on Tremont Street.	July 12, 1895	-	Boston. Society
HP4	Copy of Photograph - Elevated Structure with Steam Train of New York Elevated Railway - 59th. Street and 9th Avenue.	(Oate of Copy) Oec. 23, 1903	3976	Carp. Center
HP5	Manhattan Elevated Railroad - 9th Ave. @ 84th St. Earliest Elevated train Structure.	1891	-	Carp. Center
HP6	New York Elevated - St. Nicholas Ave., 8th Avenue.	March 11, 1891	-	Carp. Center
HP7	Union Elevated Railroad - New York Later Version of Elevated Structure.	1900	-	Carp. Center
HP8	Entries for Station Design-Architectural Competition for the BERy Elevated Mainline Structure.	1898	-	Boston Pub. Lib.
HP9	Pleasant Street Incline Looking up from Subway.	April 30, 1901	778A	MBTA
HP10	Pleasant Street Station under Construction.	June 5, 1901	821A	Private Collection
HP11	Pleasant Street Incline Crossing B&A Tracks to Castle Street.	June 5, 1901	823A	MBTA
HP12	Movable Platform Scollay Square Station Northbound Track for Temporary Use of Elevated Trains.	Jan. 3, 1903	3383	Carp. Center
HP13	Movable Platform Haymarket Station Northbound Track for Temporary Use of Elevated Trains.	Jan. 5, 1903	3385	Carp. Center
HP14	Four Representative Photographs of the Berlin Elevated Railway - Reproduced by the BERy.	-	-	Carp. Center

List of Historical Photographs

Fig. No.	Description	Date	Orig. No.	Source
HP15	Atlantic Avenue Line Beginning @ Castle & Washington Streets & Tower 'D'.	Sept. 23, 1901	1803	MBTA
HP16	Extension of Washington Street Mainline to Connect with South Portal of Washington Street Tunnel. View Looking North under Tower D @ Castle Street.	Nov. 11, 1907	5209	Boston. Society
HP17	Castle Street Wye, Tower 'D' and Extension of Mainline toward Washington Street Tunnel (under construction).	Nov. 11, 1907	5208	Carp. Center
HP18	Temporary Platform @ Park Street for Southbound Elevated Mainline Trains.	1901	-	SRA Library
HP19	First Columns on Washington Street Mainline-Roxbury Division Corner Cobb Street.	Aug. 19, 1899	291	Boston. Society
HP20	First Three Bents #191, #192, #193 Erected on Washington Street, Corner of Cobb Street.	Aug. 26, 1899	316	Boston. Society
HP21	Southerly View along Washington Street Showing Air Compressor Machine for Riveting Hammers.	Sept. 22, 1899	325	MBTA
HP22	North along Washington Street @ Cathedral View from Street.	Nov. 1, 1899	333	MBTA
HP23	North Along Washington Street @ Malden Street and Cathedral. View from Rooftop.	Nov. 1, 1899	338	MBTA
HP24	Wagon for Hauling Girders with Horse Team.	Nov. 1, 1899	339	MBTA
HP25	Closeup of Compressed Air Machine for Riveting Hammers.	Dec. 28, 1899	388	MBTA
HP26	Erection of Bents along Atlantic Avenue (One of few photographs showing traveller and erection crew at work during day time hours).	Feb. 1, 1901	1373	MBTA

List of Historical Photographs

Fig. No.	Description	Date	Orig. No.	Source
HP27	Erection of Transverse 8eams on Atlantic Avenue Elevated Structure.	Feb. 2, 1901	1384	MBTA
HP28	Dover Street Station Looking North along Washington Street.	April 30, 1901	776A	MBTA
HP29	Elevation of Dover Street Station Structure Looking West along Dover St. (now Berkley Street).	1900	864	Boston. Society
HP30	Erection of Canopy Framing at Dover Street Station.	-	-	MBTA
HP31	Mainline Looking South at Dover Street Station. Tracklaying.	Jan. 16, 1901	799	MBTA
HP32	Washington Street Mainline - Looking South Just above Laconia Street & South of Dover Street Station. View of Temporary Dover Street Station under Construction.	June 12, 1912	832C	Boston. Society
HP33	View under Dover Street Looking South Showing Reconstruction of Dover Street Station.	Aug. 26, 1912	844C	8oston. Society
HP34	Structural Steel Framing - Northampton Street Station.	Oct. 20, 1900		MBTA
HP35	Northampton Street Station - Progress Photo Exterior Sheathing.	Dec. 21, 1900	855	MBTA
HP36	Northampton Street Station - View Prior to Opening.	May 23, 1901	811A	MBTA
HP37	Northampton Street Station in Use. Rooftop View.	Aug. 5, 1901	854A	MBTA
HP38	Interior View - Rowes Wharf Station (Similar to that of Dover and Northampton Stations.)	July 29, 1901	1B38	MBTA
HP39	View along Mainline - Looking South at Northampton Street Station Platform Extension.	Nov. 25, 1908	914B	Carp. Center

List of Historical Photographs

Fig. No.	Description	Date	Orig. No.	Source
HP40	Erecting of Steel along Washington Street @ Sterling Street - View from Rooftop.	Oec. 20, 1899	394	Boston. Society
HP41	Oudley Street @ Washington Street - Wye on Mainline Site of Future Tower F. Track laying.	Jan. 9, 1901	-	MBTA
HP42	Oudley Street Terminal - Construction View of Interior-Looking South from East Loop Platform.	Oec. 29, 1900	B51	Boston. Society
HP43	Dudley Street Station - West Waiting Room-Looking North, Interior View.	Oec. 29, 1900	B4B	Boston. Society
HP44	Oudley Terminal - Interior View Looking North Prior to Opening.	May 3, 1901	784A	SPNEA
HP45	Oudley Street Terminal - East Loop.	Oct. 29, 1901	880A	SPNEA
HP46	Oudley Street Terminal - View of Inclines from South.	April 24, 1902	914A	MBTA
HP47	Oudley Street Terminal - View of East Loop from Roof.	June 5, 1902	925A	MBTA
HP4B	Oudley Street Terminal - View from Roof toward West.	June 6, 1902	927A	MBTA
HP49	Oudley Street Terminal - West Side of Track View of Newstand.	May 5, 1902	-	BTA
HP50	Dudley Street Terminal - East Side of Track Interior View Looking South.	Nov. 5, 1902	3337	MBTA
HP51	Interior of Switch Tower F at Dudley Street.	July 17, 1901	3216	MBTA
HP52	Switch Tower G at Bartlett Street - Exterior View.	Sept. 9, 1901	B6BA	MBTA
HP53	View along Mainline Track from Oudley Street to Guild Street Yard Looking South at Bartlett Building.	190B	991B	Carp. Center

List of Historical Photographs

Fig. No.	Description	Date	Orig. No.	Source
HP54	View of Guild Street Yard at Washington and Guild Streets - Looking South.	Dec. 18, 1901	882A	MBTA
HP55	Open Vestibule Wooden Elevated Car #0110 @ Tower F.	May, 19, 1902	-	MBTA
HP56	Interior View of Early Elevated Train Car #069.	Sept. 6, 1902	3314	MBTA
HP57	View of Berlin Train and Elevated Station	Sept. 9. 1901	-	Carp. Center
HP58	End Elevation & Cross Section of #3 Elevated Car.	Sept. 10, 1909	-	MBTA
HP59	View of Wreck at Dudley Street to East of Tower F.	Aug. 4, 1910	801C	MBTA
HP60	View of Bent Beams over Dudley Street after Train Wreck.	Aug. 4, 1910	-	MBTA
HP61	Dudley Street Station - New Steel Work for New Southbound Platform. View looking West.	Aug. 24, 1908	979B	Carp. Center
HP62	Dudley Street Station. View Looking South along Mainline with New Framing for Southbound Platform.	Aug. 24, 1908	981B	Carp. Center
HP63	Dudley Street Station. View from Street Looking North at New Construction on Loop.	April 10, 1908	998B	Carp. Center
HP64	Dudley Street Station. Work on East Loop. View from Street.	Jan. 1, 1909	888B	Carp. Center
HP65	Dudley Street Station. Surface Level Looking Southeast.	Oct. 7, 1909	787B	Carp. Center
HP66	Dudley Street Station View from Street-Looking East at New Work under Southbound Platform.	Nov. 29, 1909	764B	Carp. Center
HP67	Dudley Street Station Platform of West Loop.	Dec. 16, 1909	741C	Carp. Center

List of Historical Photographs

Fig. No.	Description	Date	Orig. No.	Source
HP68	Dudley Street Station. View Looking North at Progress on Platforms and Footbridge.	Jan. 20, 1910	748C	Carp. Center
HP69	Dudley Street Station. Interior View of Waiting Room Pavilion - East Loop.	April 7, 1910	758C	Carp. Center
HP70	Dudley Street Station. View of East Loop from Roof.	April 17, 1910	761C	Carp. Center
HP71	Dudley Street Station Work on East Loop-Looking North.	April 27, 1910	767C	Carp. Center
HP72	Dudley Street Station-East Loop and Pavilion.	May 24, 1910	770C	Carp. Center
HP73	Dudley Street Station. East Loop. View Looking North from Platform.	May 24, 1910	774C	Carp. Center
HP74	Dudley Street Station. Birdseye View of Complex, Looking North, after Reconstruction.	Sept. 20, 1910	819C	Carp. Center
HP75	Dudley Street Station. View along Warren Street of East Loop Looking North.	1940	-	Carp. Center
HP76	Dudley Street Station. View along Dudley Street Looking West at Loop.	1940	-	Carp. Center
HP77	Dudley Street Station. View of 12 Bench Open Car Looking South from Platform of West Loop Incline.	1910	-	MBTA
HP78	Guild Street Yard at Washington Street-Looking South. View of Traveller Starting Work on Forest Hills Extension.	May 3, 1906	6024	Carp. Center
HP79	Washington Street Looking North. View of Guild Street Yard and Air Compressor Machine for Riveting Hammer.	May 12, 1906	6030	Carp. Center
HP80	Traveller on Washington Street near Cedar Street-Looking North.	May 12, 1906	6033	Carp. Center

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Fig. No.	Description	Date	Orig. No.	Source
HP81	View North along Washington Street near Guild Street.	May 12, 1906	6034	Carp. Center
HP82	View South along Washington Street at Kingsbury Street-Showing Start of Transverse Bracing.	June 19, 1906	6071	Carp. Center
HP83	View of Mainline Looking West at Highland Park.	July 2, 1906	6075	Carp. Center
HP84	View South along Washington Street from Townsend Street.	July 16, 1906	6078	Carp. Center
HP85	View South along Structure at Townsend Street Showing Installation of Cross Bracing between Girders.	July 16, 1906	6080	Carp. Center
HP86	View North along Washington Street @ Bray Street Showing Second Section of Transverse Bracing.	Aug. 13, 1906	6081	Carp. Center
HP87	View South along Washington Street @ Bragdon Street-Showing Staging for Riveting Crews. Egleston Square is in Distance.	Aug. 13, 1906	6083	Carp. Center
HP88	View of Egleston Square Station Looking North along Washington Street.	Aug. 22, 1906	6088	Carp. Center
HP89	View Looking North along Mainline Structure at Franklin Brewery Company.	Sept. 25, 1906	6095	Carp. Center
HP90	View North along Mainline Showing Tie Laying near Circuit Street.	Oct. 18, 1906	6103	Carp. Center
HP91	View Towards Structure South of Forest Hills Street and North of Green Street.	Oct. 19, 1906	6106	Carp. Center
HP92	View South along Washington Street near Union Avenue.	Nov. 7, 1906	6114	Carp. Center
HP93	Egleston Square Station View South from New Concrete Platform.	July 30, 1908	6239	Carp. Center

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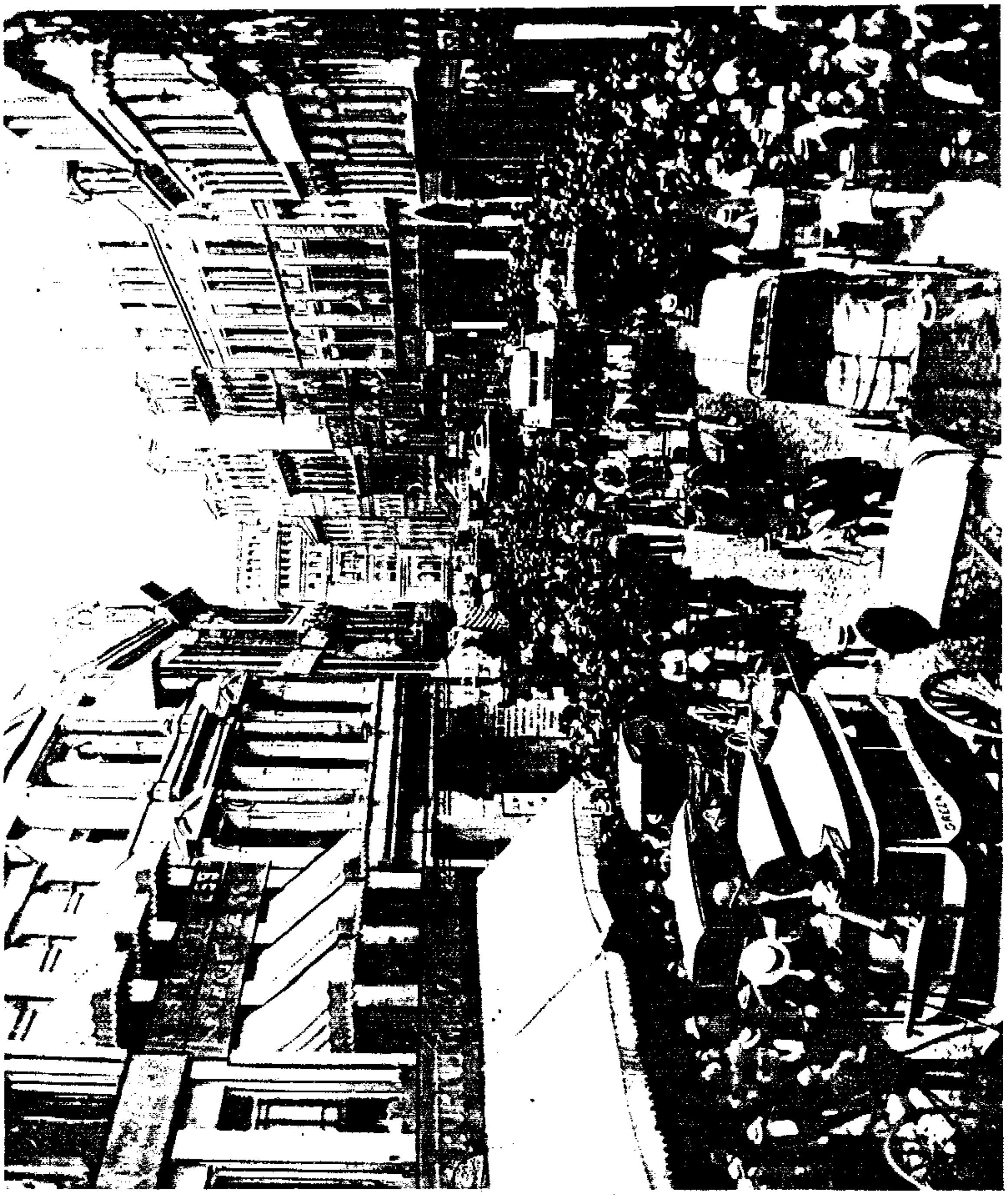
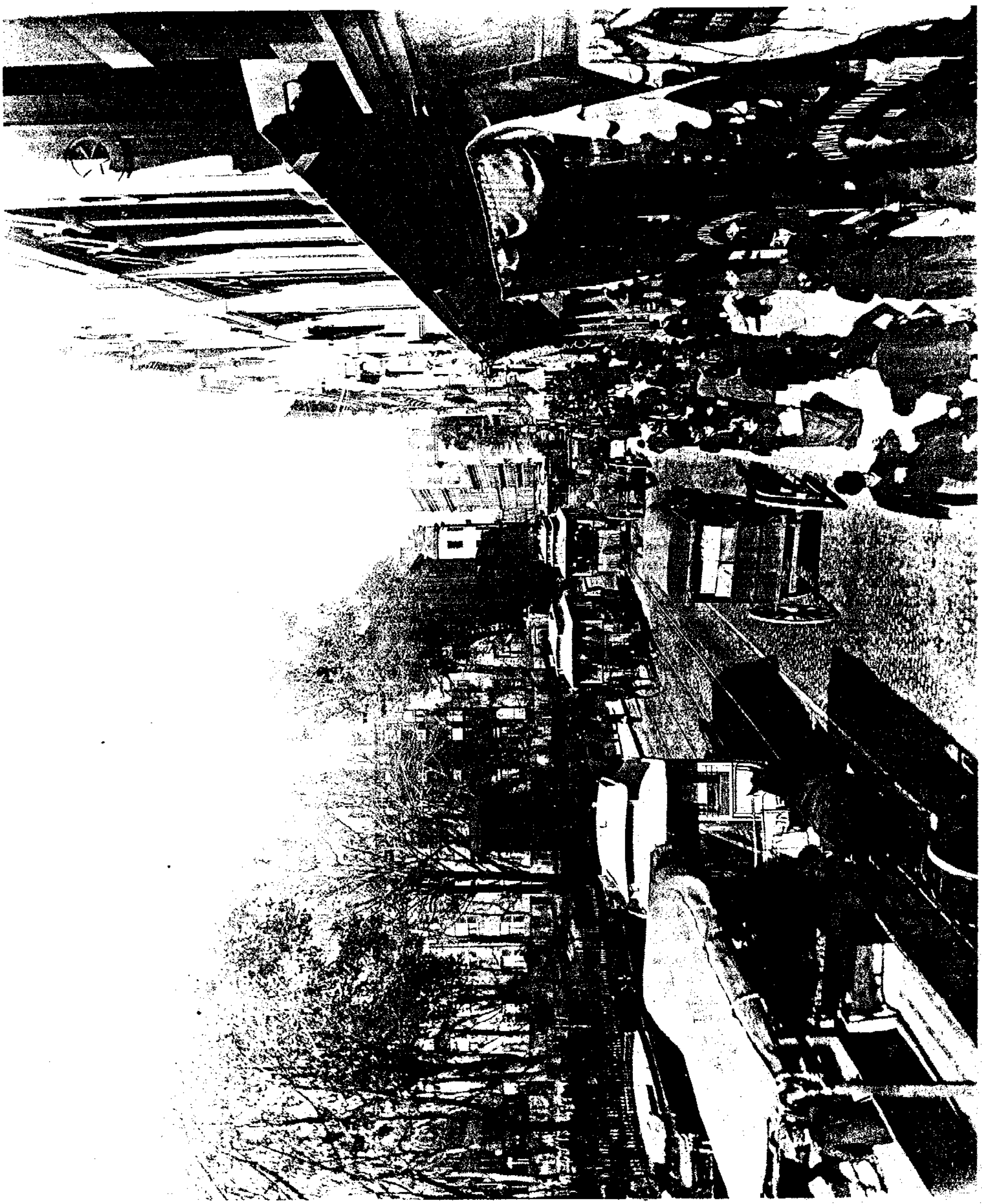
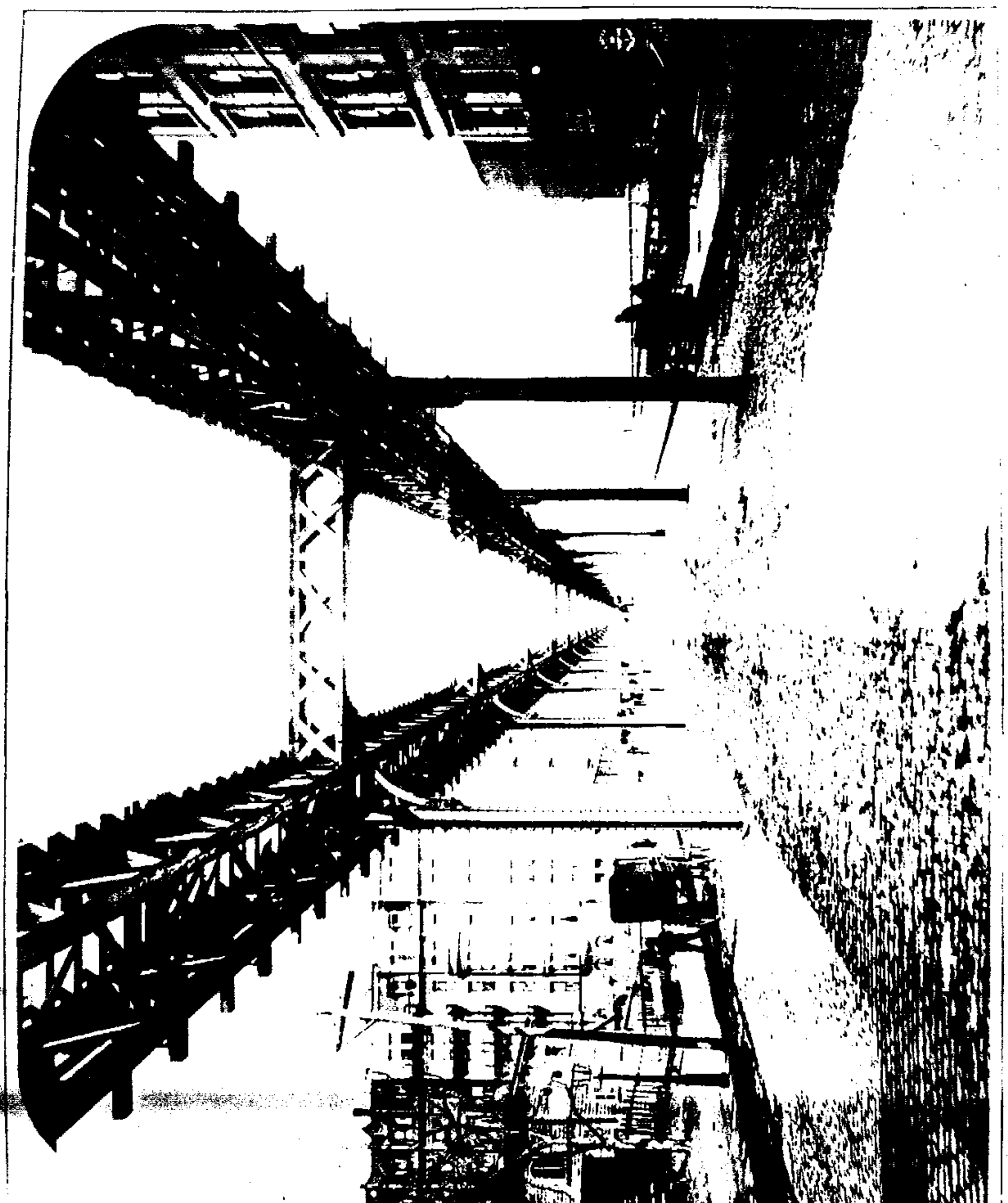
Fig. No.	Description	Date	Orig. No.	Source
HP94	View of Egleston Square Station Looking South from Columbus Avenue.	Sept. 10, 1908	6269	Carp. Center
HP95	Egleston Square Station-East Elevation.	Oct. 5, 1908	6271	Carp. Center
HP96	Egleston Square Station Looking North at Canopy Framing.	Oct. 6, 1908	6273	Carp. Center
HP97	Interior of Lower Level - Egleston Square Station.	May 29, 1909	6368	Carp. Center
HP98	View along Mainline at Green Street Station Looking North. Framing of Platforms.	Feb. 21, 1912	6061A	Carp. Center
HP99	View from under Green Street Station Looking South.	Feb. 21, 1912	6062A	Carp. Center
HP100	Setting of Column Bolts in Concrete Foundation.	May 23, 1908	6043	Carp. Center
HP101	Setting Column Shoe Casting on Anchor Bolts.	June 6, 1906	6061	Carp. Center
HP102	Stony Brook Culvert with Concrete Piers for Bent #774.	May 13, 1908	6218	Carp. Center
HP103	View of Forest Hills Square and Forest Hills Railroad Station Showing Streetcars Bound for Destinations Southwest of Boston.	c. 1905	-	Private Collection
HP104	View North of Traveller Erecting a Single Pylon Portion of Structure over Arborway.	Aug. 19, 1908	6242	Carp. Center
HP105	View North from Forest Hills - Team and Wagon Unloading Steel Girder.	Aug. 19, 1908	6246	Carp. Center
HP106	Forest Hills - View of New Haven R.R. Bridge over Arborway and of Mainline Crossing Arborway.	Aug. 24, 1908	6250	Carp. Center
HP107	Mainline Structure Entering Forest Hills Station Structural Framing. View Looking North along Washington Street.	April 16, 1909	6313	Carp. Center

List of Historical Photographs

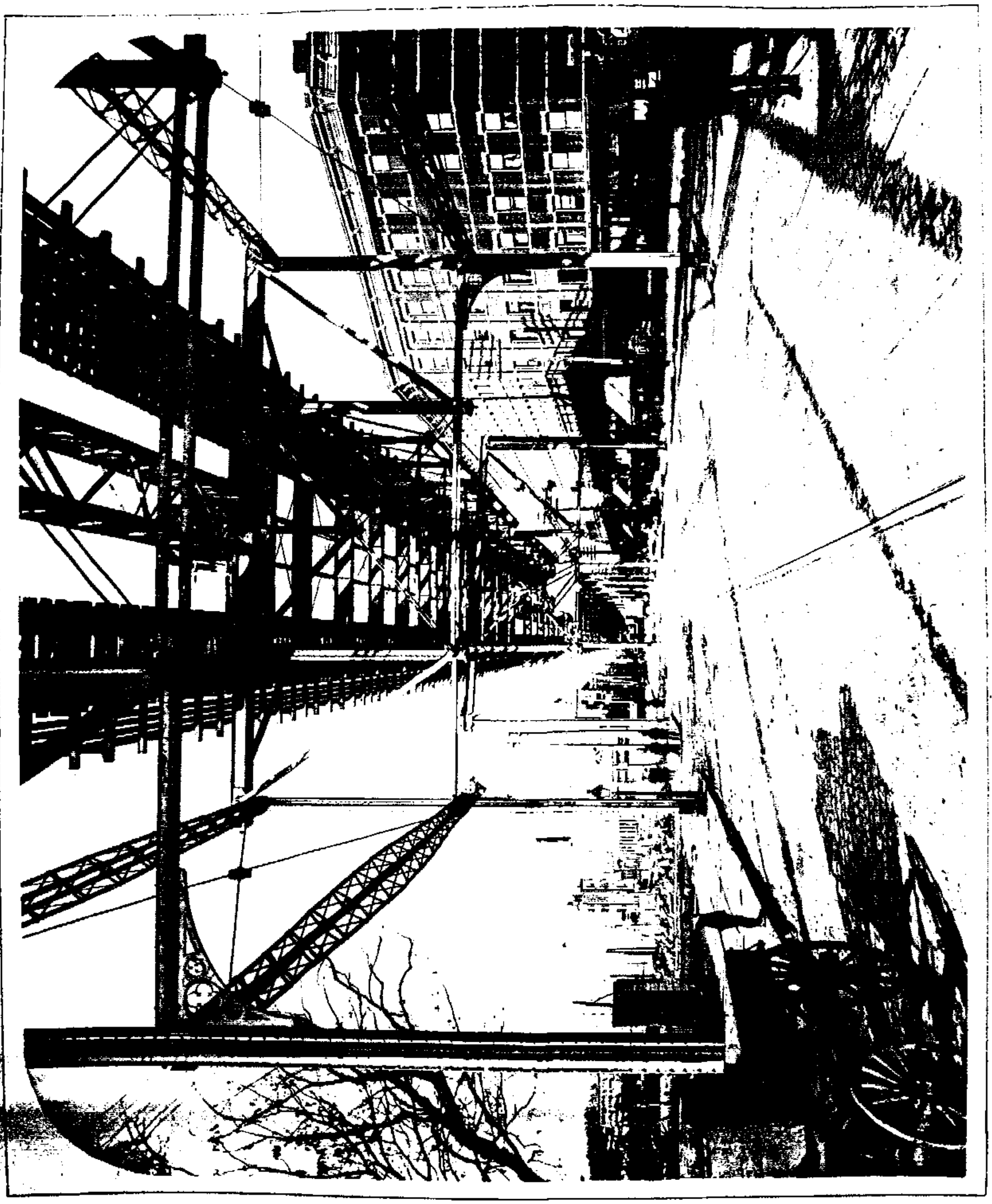
Fig. No.	Description	Date	Orig. No.	Source
HP108	View North Underneath Forest Hills Station Structural Steel Framing.	May 5, 1909	6331	Carp. Center
HP109	Concrete Reinforcing on Arborway Crossing.	May 8, 1909	6333	Carp. Center
HP110	Reinforcing for Concrete on Mainline over Arborway View Looking West.	May 21, 1909	6360	Carp. Center
HP111	Covering Steel Girder with Concrete at Arborway.	June 28, 1909	6394	Carp. Center
HP112	Metal Lath Installed over Steel Girders Prior to Concreting. View along Mainline Looking South.	June 1, 1909	6375	Carp. Center
HP113	Forest Hills Station - View South from Platform.	Feb. 8, 1912	6058A	Carp. Center
HP114	Forest Hills Station - View from Arborway Looking South.	July 28, 1910	6031A	Carp. Center
HP115	Forest Hills Station - View Looking North from Railroad Embankment.	Nov. 16, 1909	6489	Carp. Center
HP116	Forest Hills Station and New Haven R.R. Station - View from Coal Tower Looking South.	Nov. 18, 1982	6498	Carp. Center
HP117	View of Arborway Train Storage Yard Incline from Mainline - Looking East.	1910	6045A	Private Collection



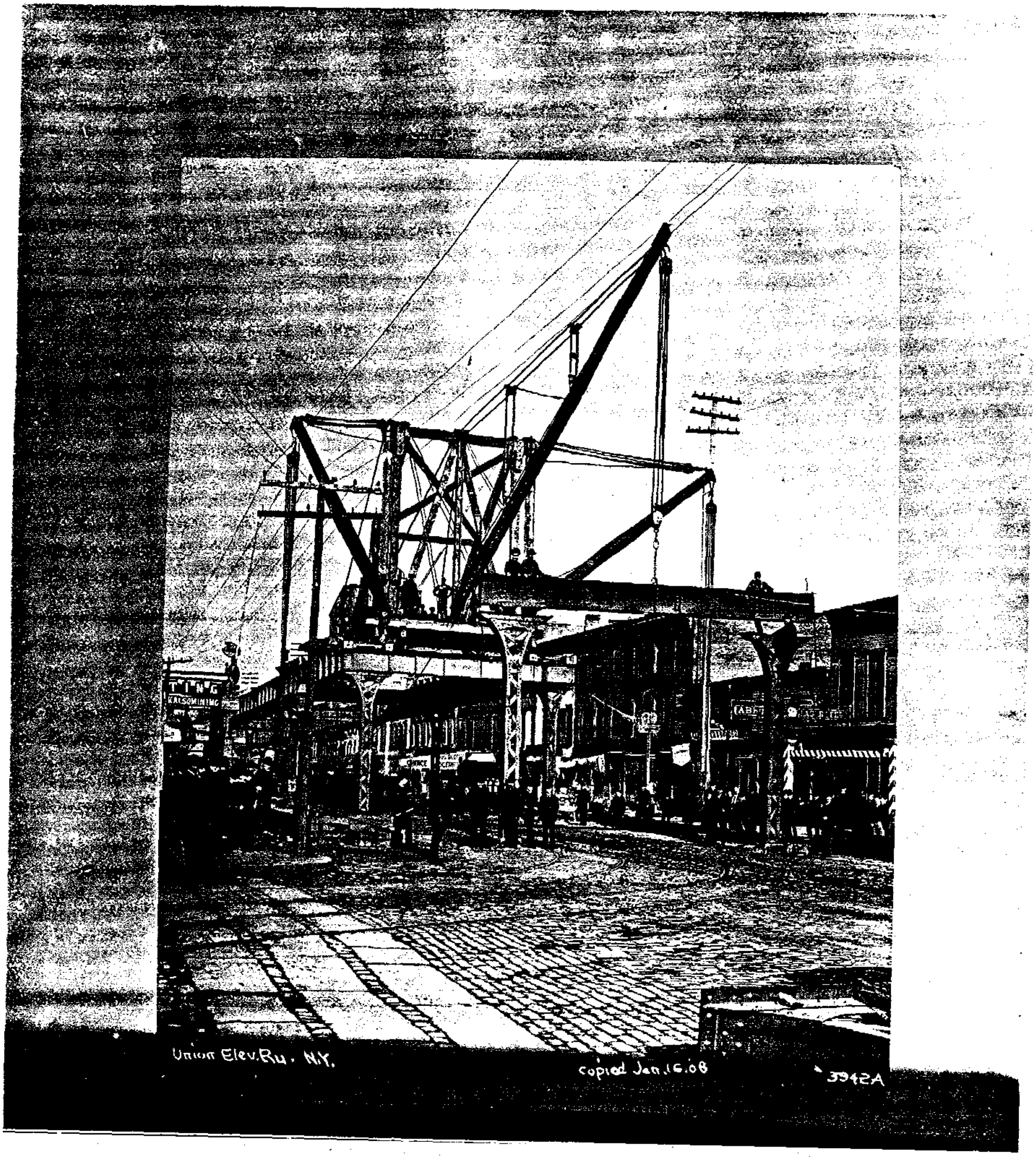


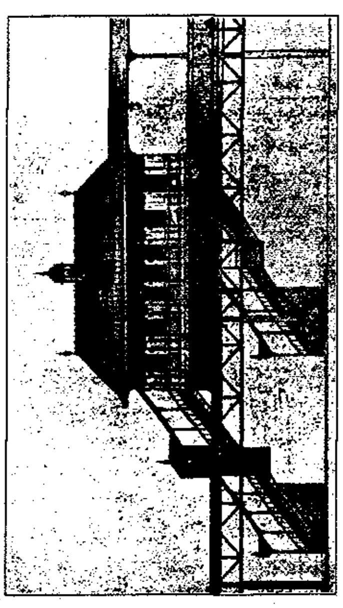


MANHATTAN ELEVATED RAILROAD NEW YORK
9TH AVE. AT 84TH ST.
Looking North
1891

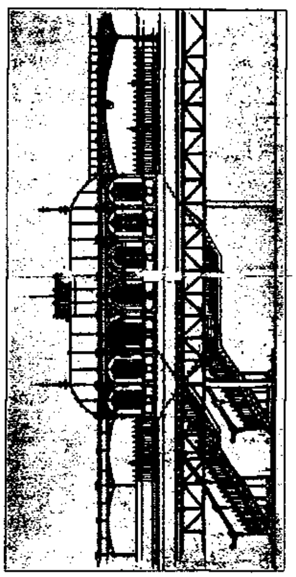


Copy of large Photo. St. Nicholas crossing [illegible] 3590A

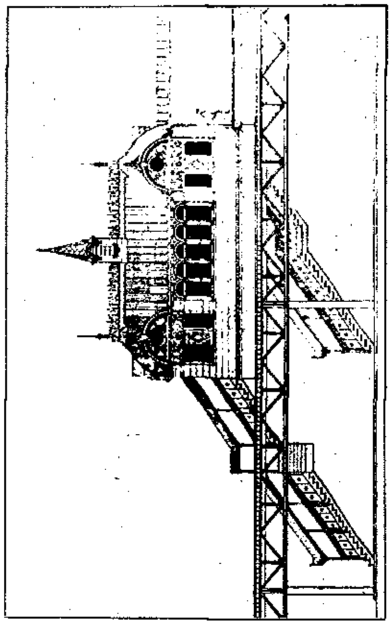

Union Elev. Ry. N.Y.
copied Jan.16.08
3942A



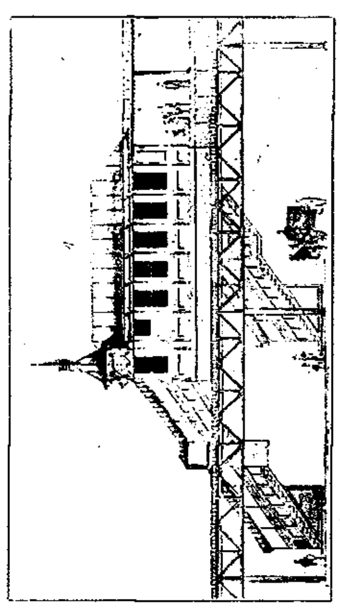
A. W. LONGFELLOW, JR.,
(Accepted Design.)



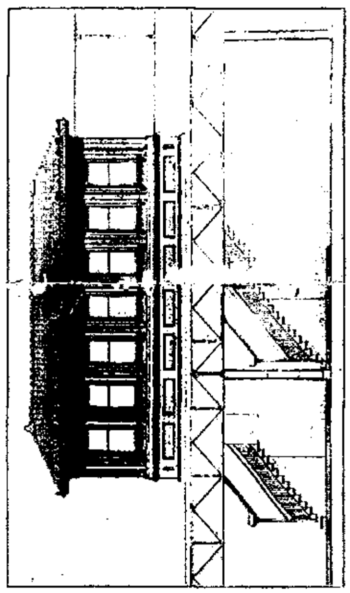
J. WILLIAMS BEAL.



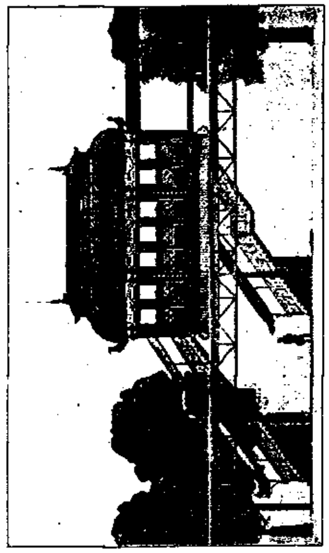
ANDREWS, JACQUES & RANTOUL.



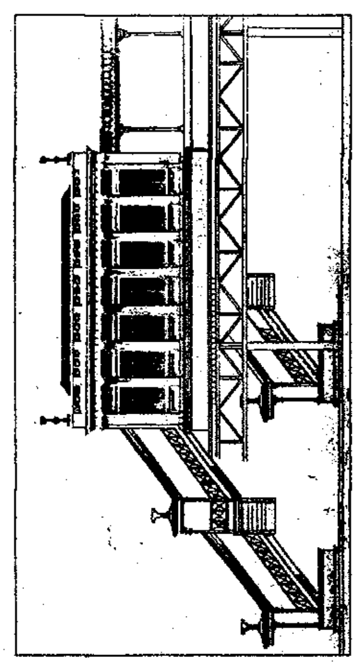
CABOT, EVERETT & MEAD.



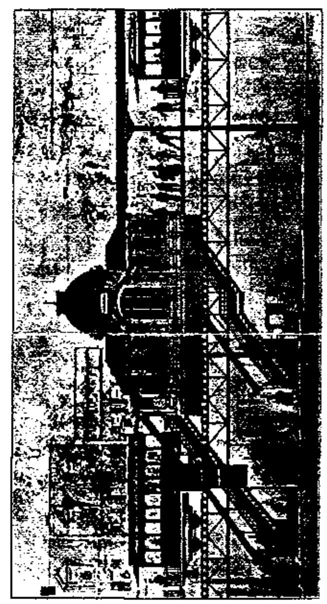
SHAW & HUNNEWELL.



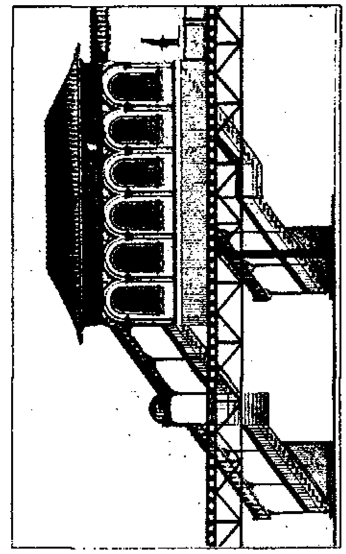
J. RANDOLPH COOLIDGE.



C. H. BLACKALL.

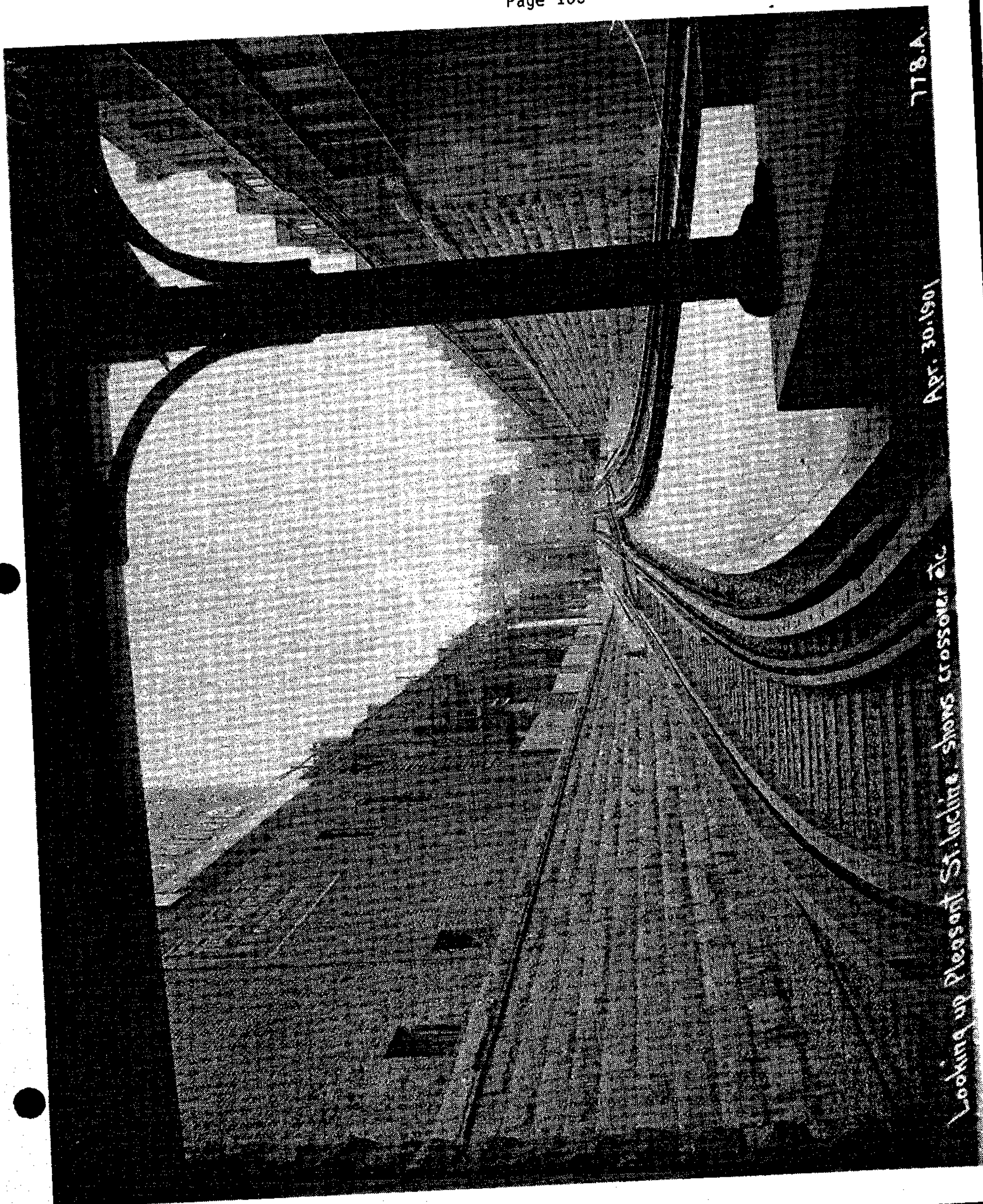


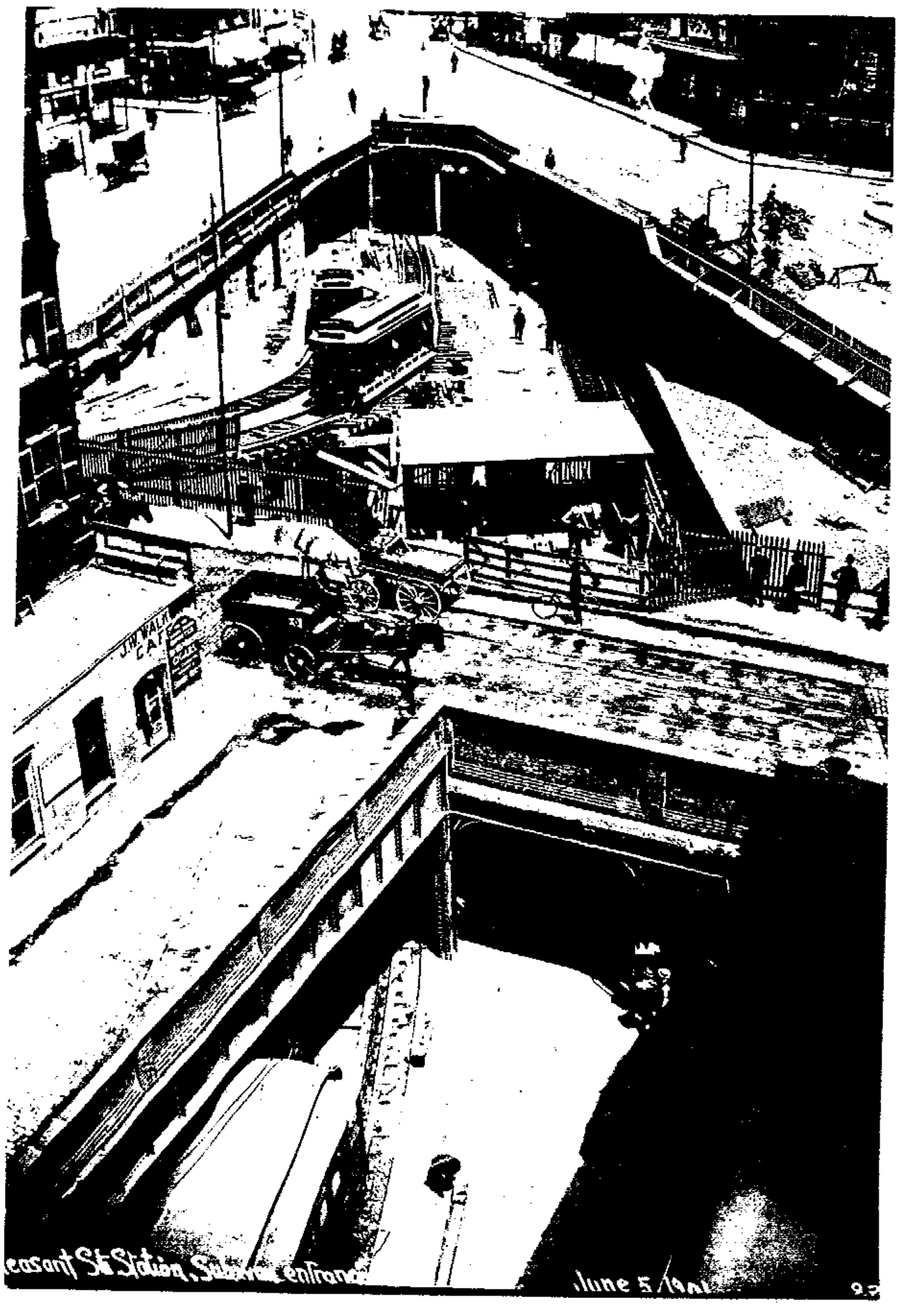
PETERS & RICE.

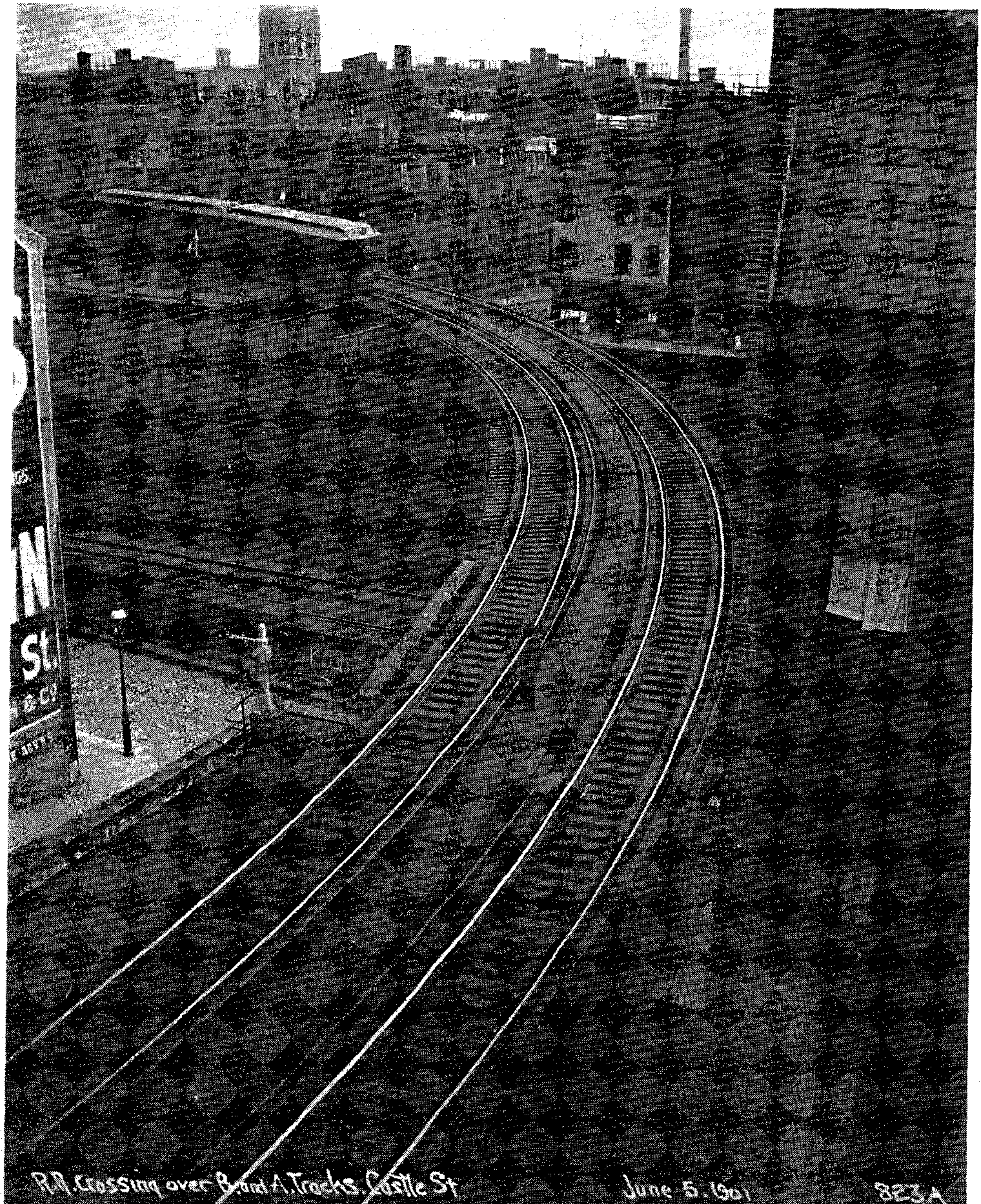


SHEPLEY, RUTAN & COOLIDGE.

COMPETITIVE DESIGNS FOR BOSTON ELEVATED RAILWAY STATIONS.

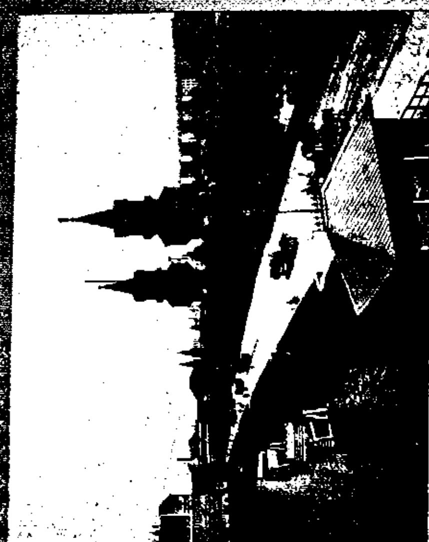

778.A.
Apr. 30.1901
Looking up Pleasant St. Incline. Shows crossover etc


easant St Station,
June 5


R.R. Crossing over B and A. Tracks. Castle St
June 5. 1901
823.A


Movable platform. Scollay Sq. North bound Track
Jan. 3. 1903
*3383


Movable platform, Heel raised. Haymarket Sq. N. bound.
Jan. 5. 1903
#3385



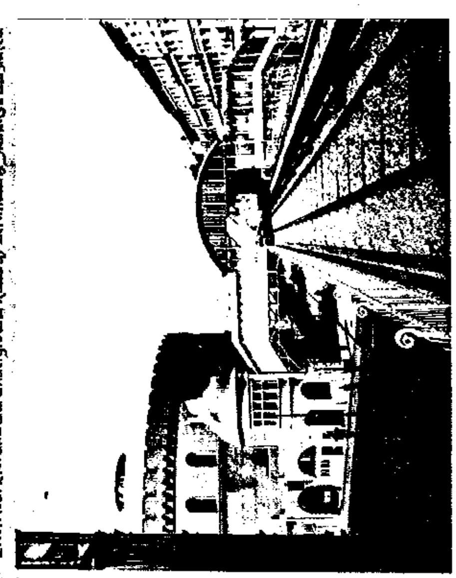
"Oberbaum"-Bridge with the Elevated and Station

Electrical Elevated and Underground Railway Berlin

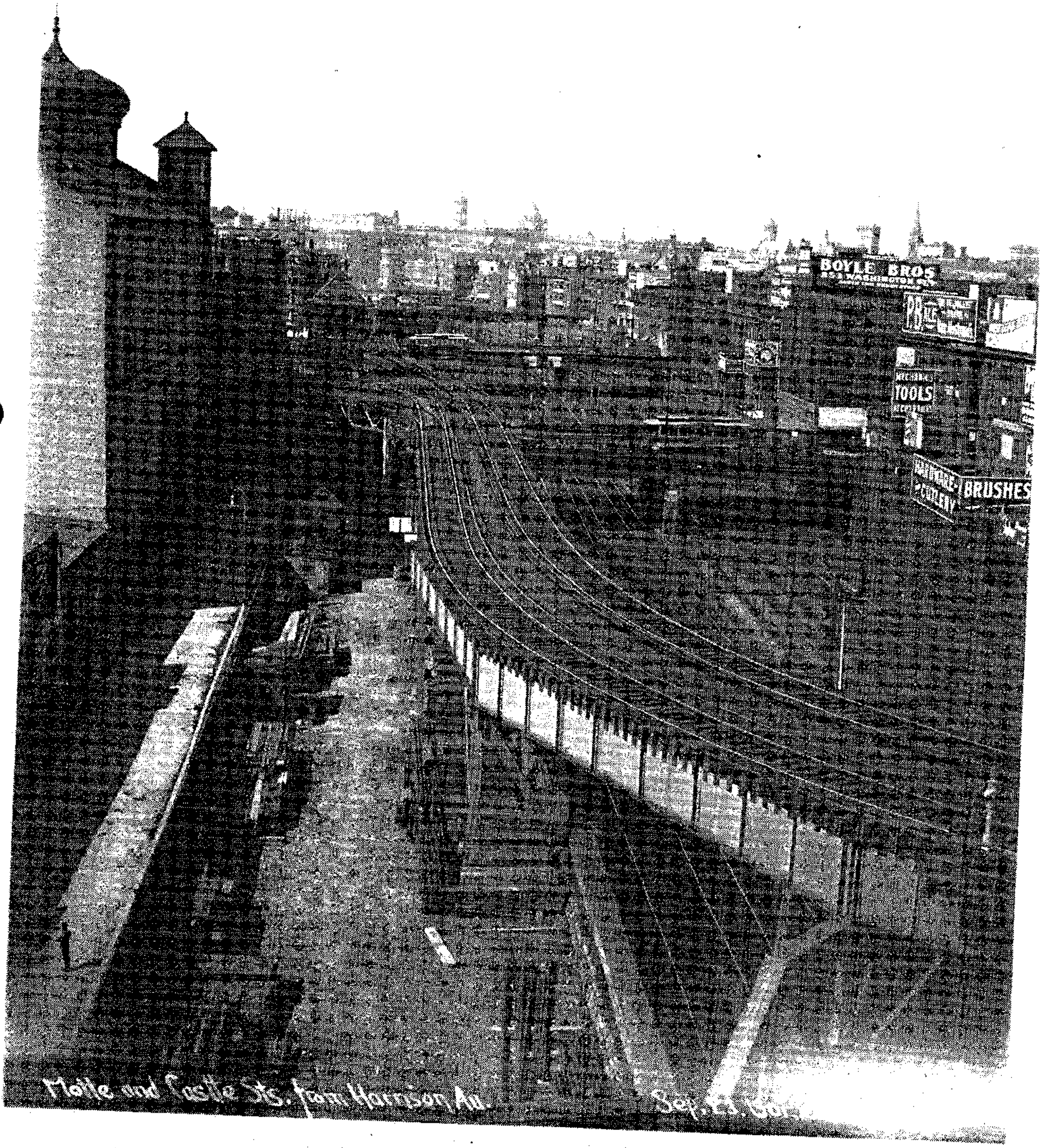
Hallesches Thor station

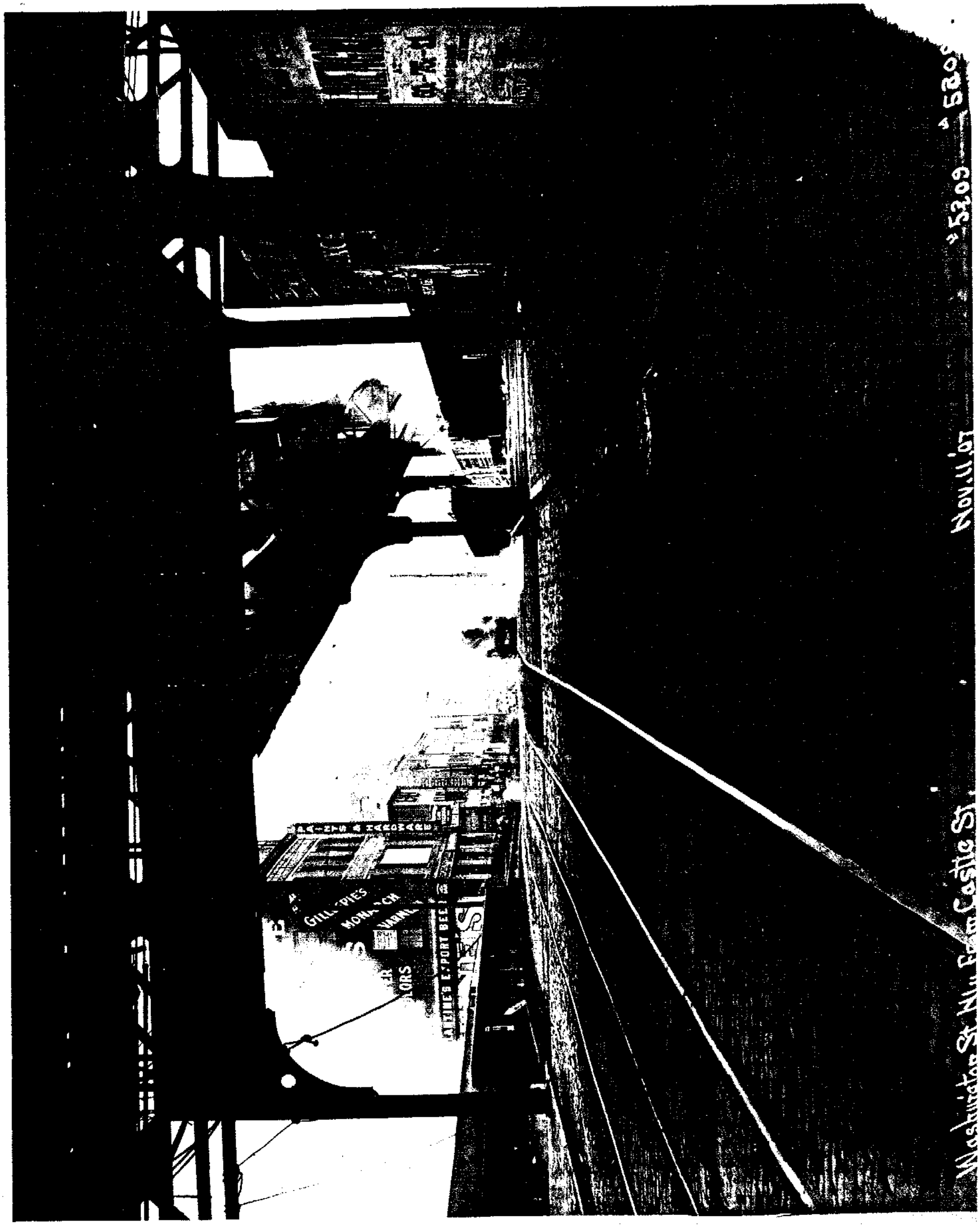
Nollendorf Platz station

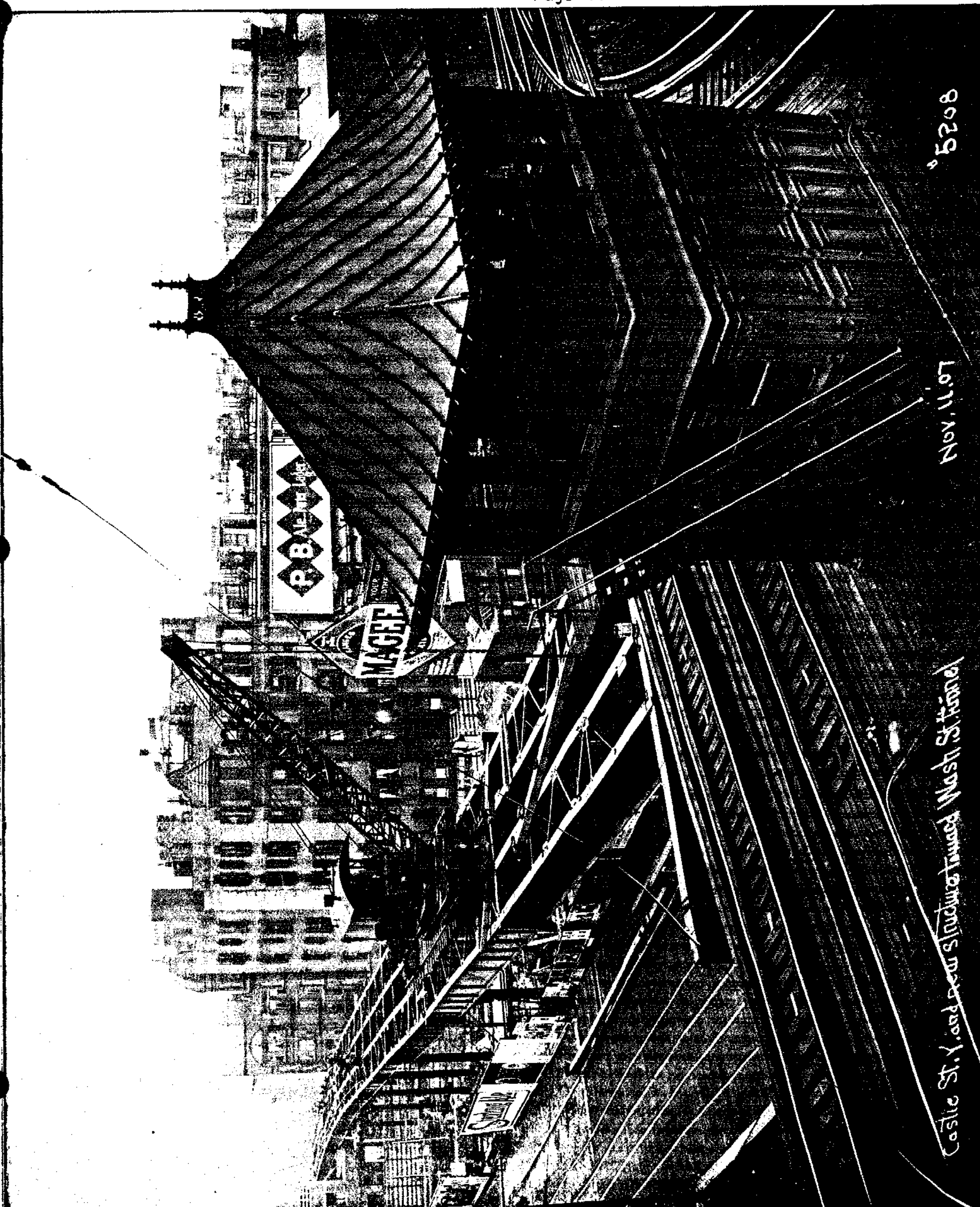
Electrical Elevated and Underground Railway Berlin made by Siemens & Halske A.G.

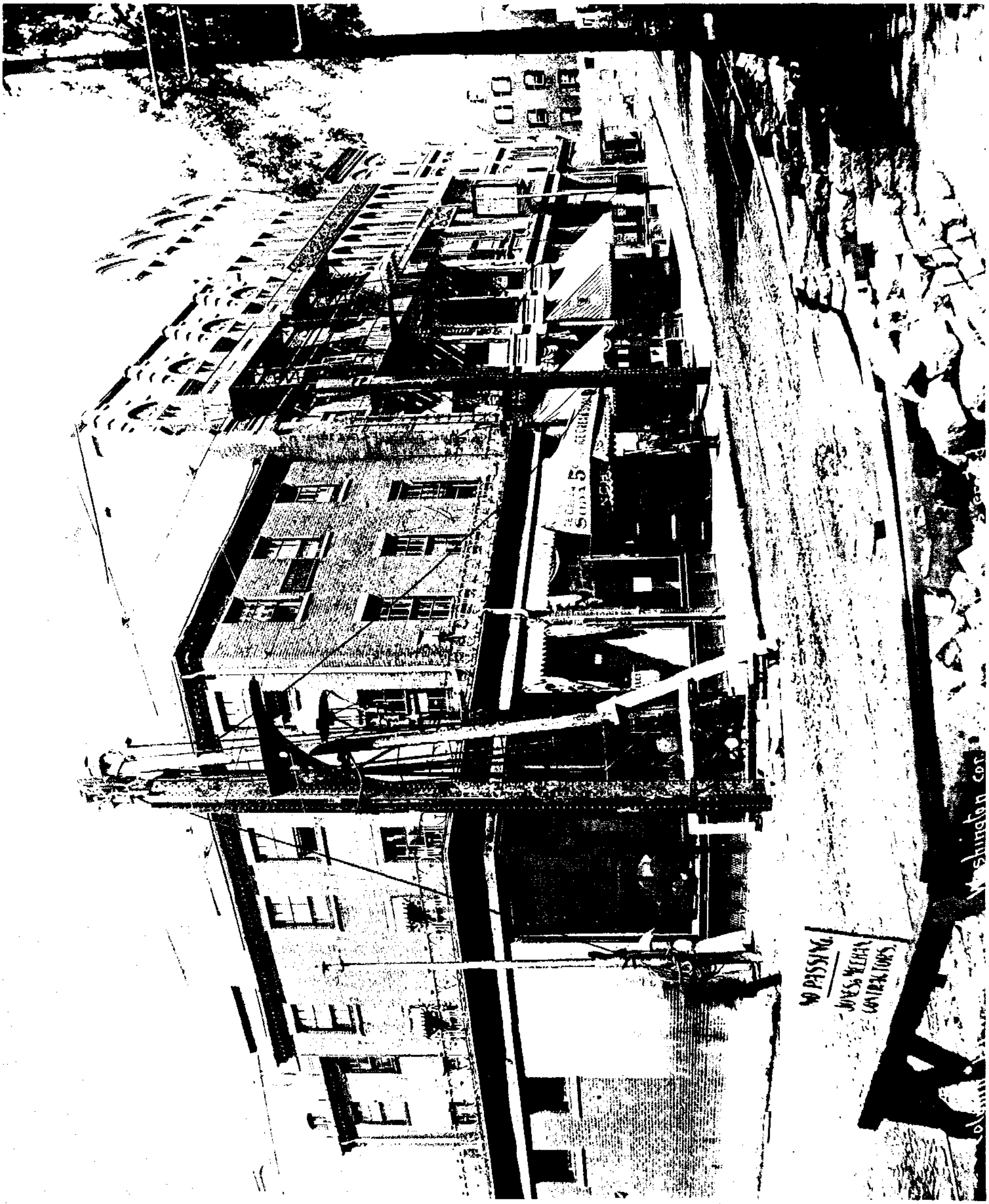


Prinzenstrasse station


BOYLE BROS
TOOLS
BRUSHES
Motte and Castle Sts. from Harrison Av.


Nov. 11. 07
5309


5208
Nov. 11, 07
Castle St. Y. and new structure toward Wash St. tunnel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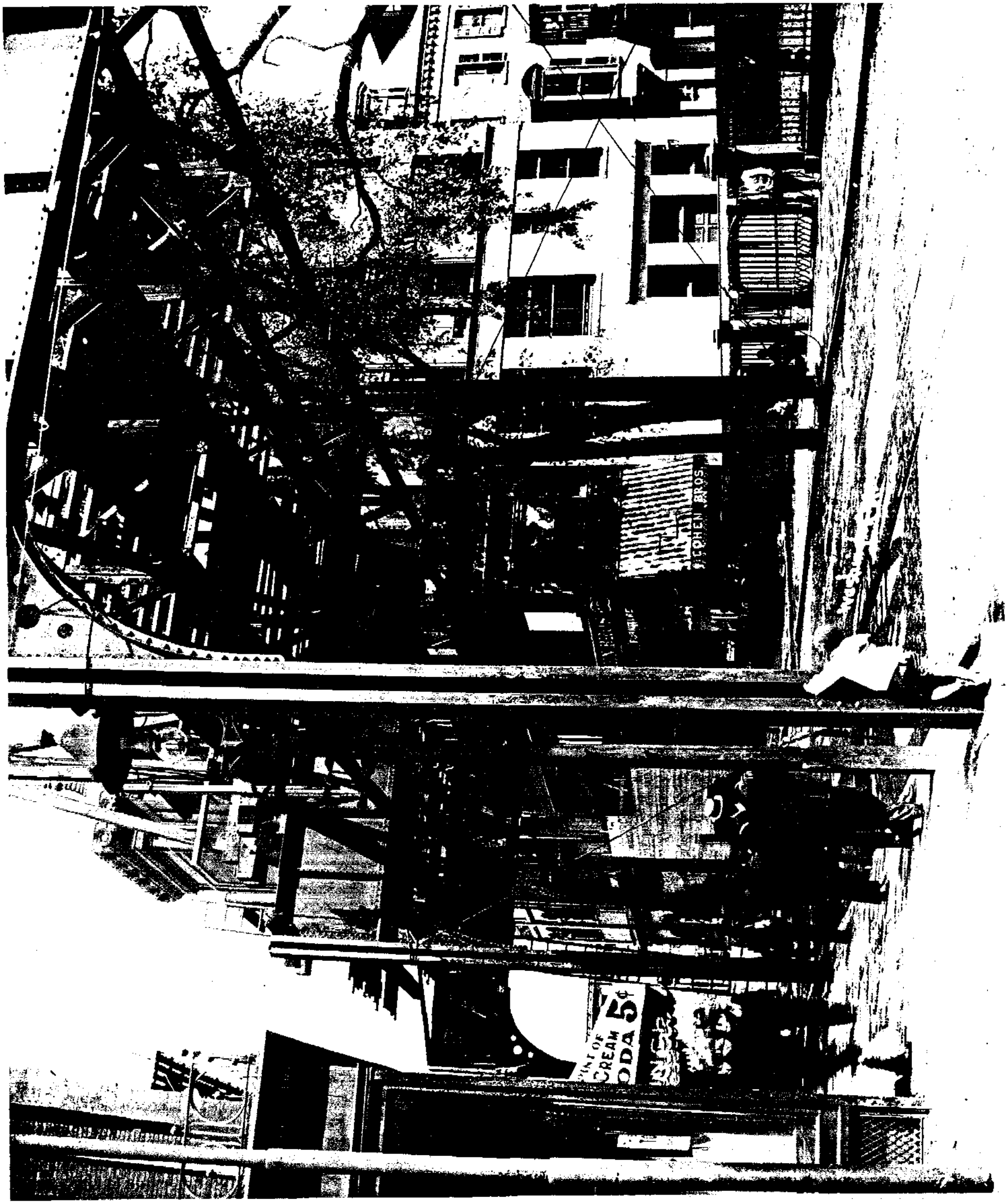
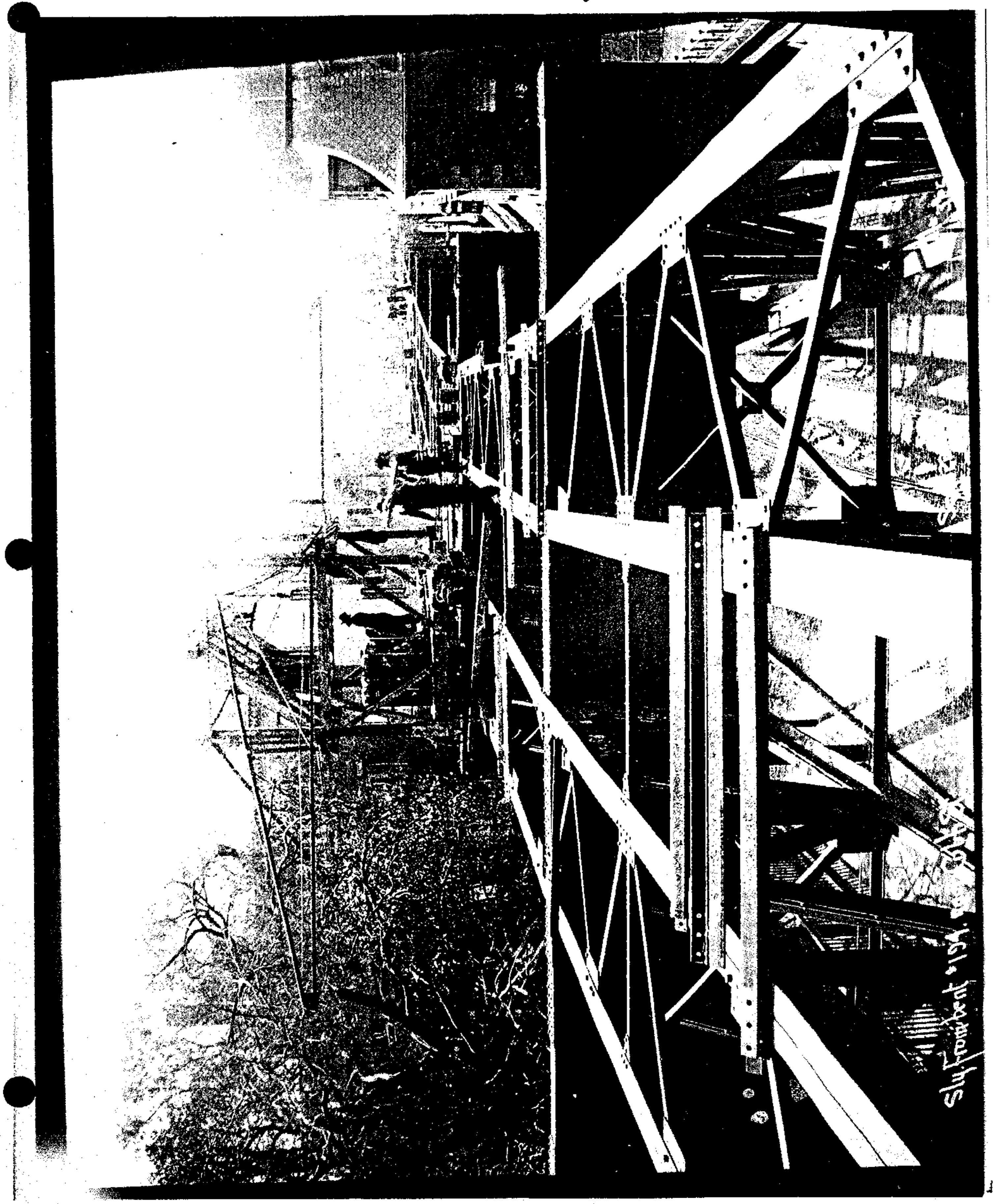
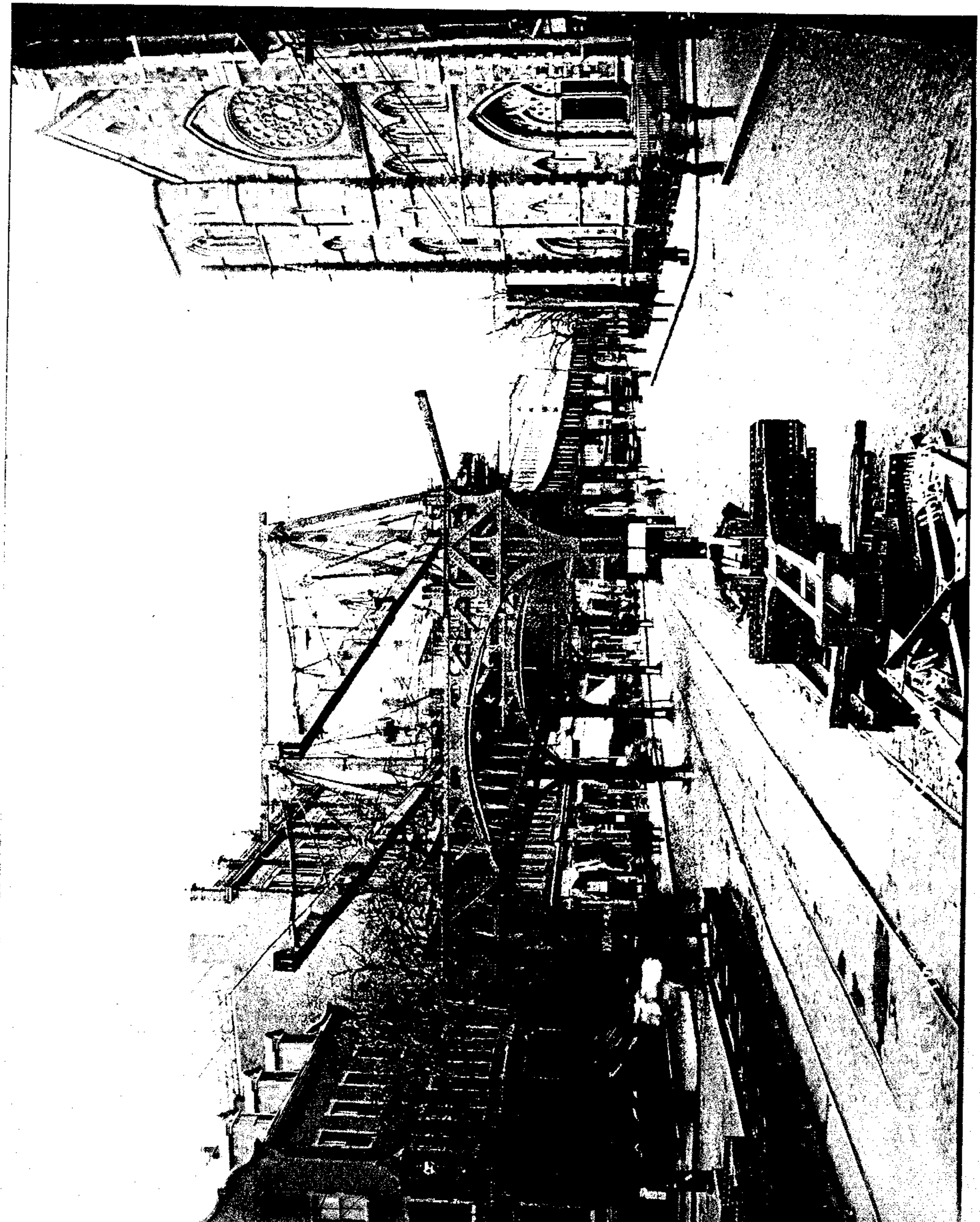
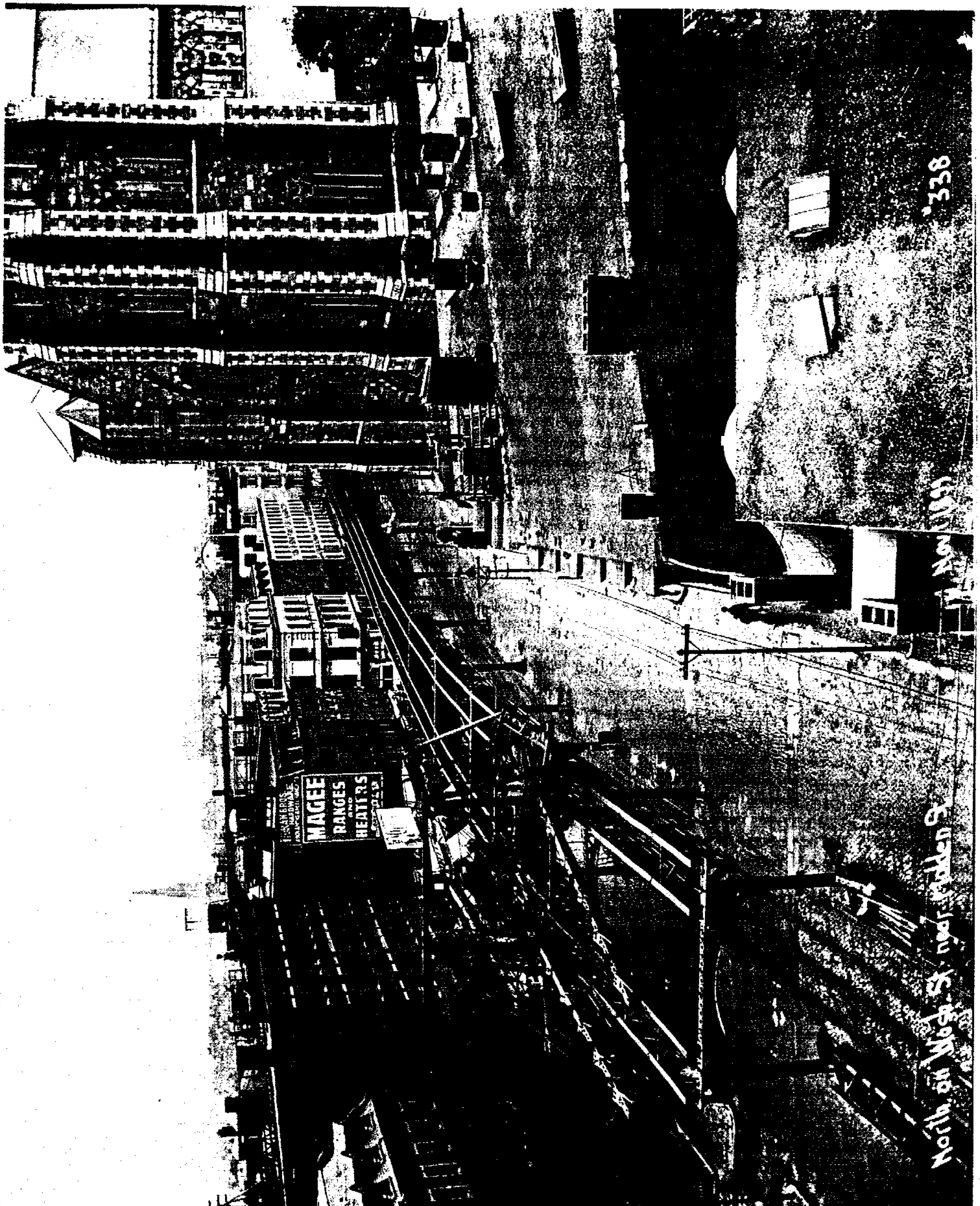
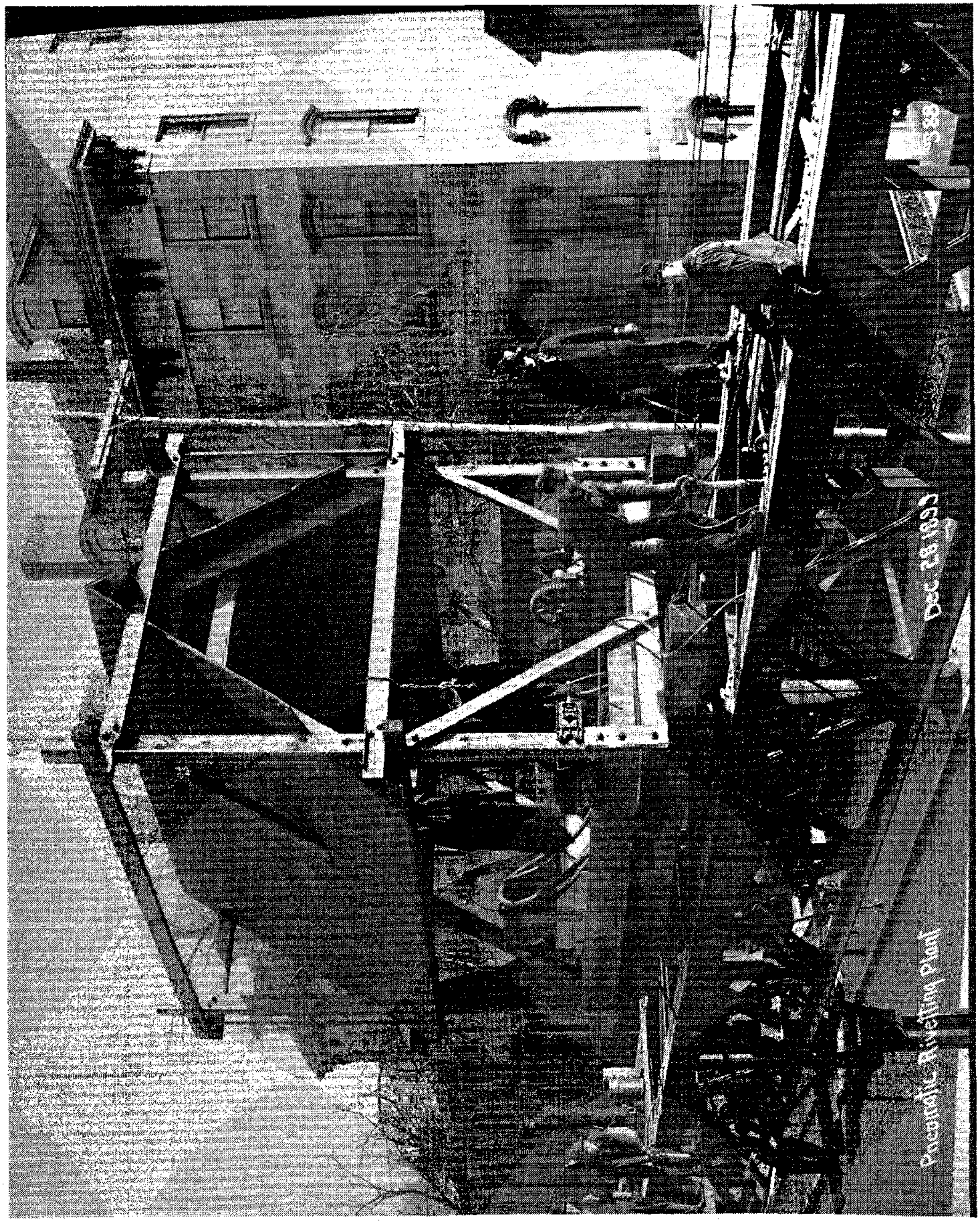

COHEN BROS.

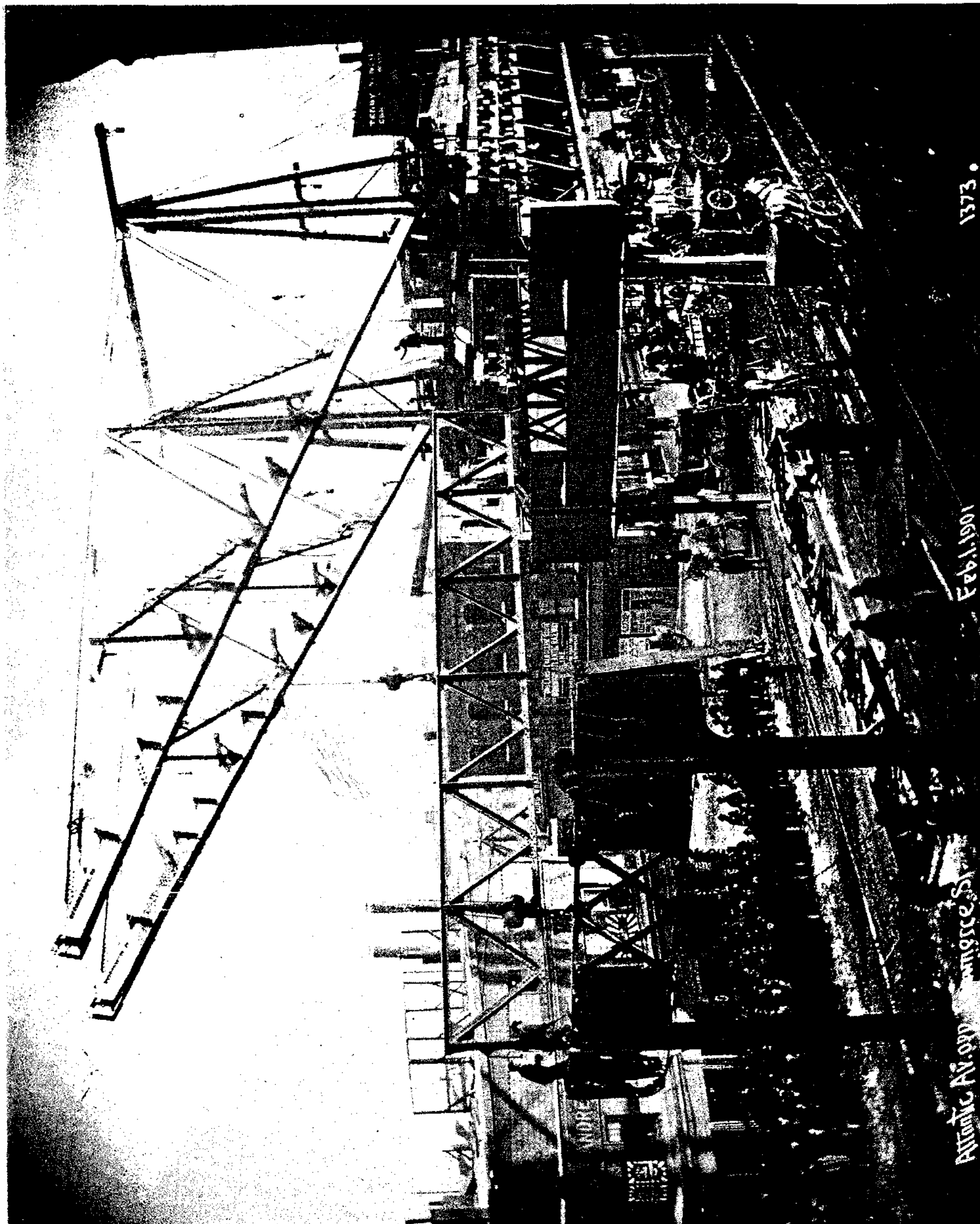




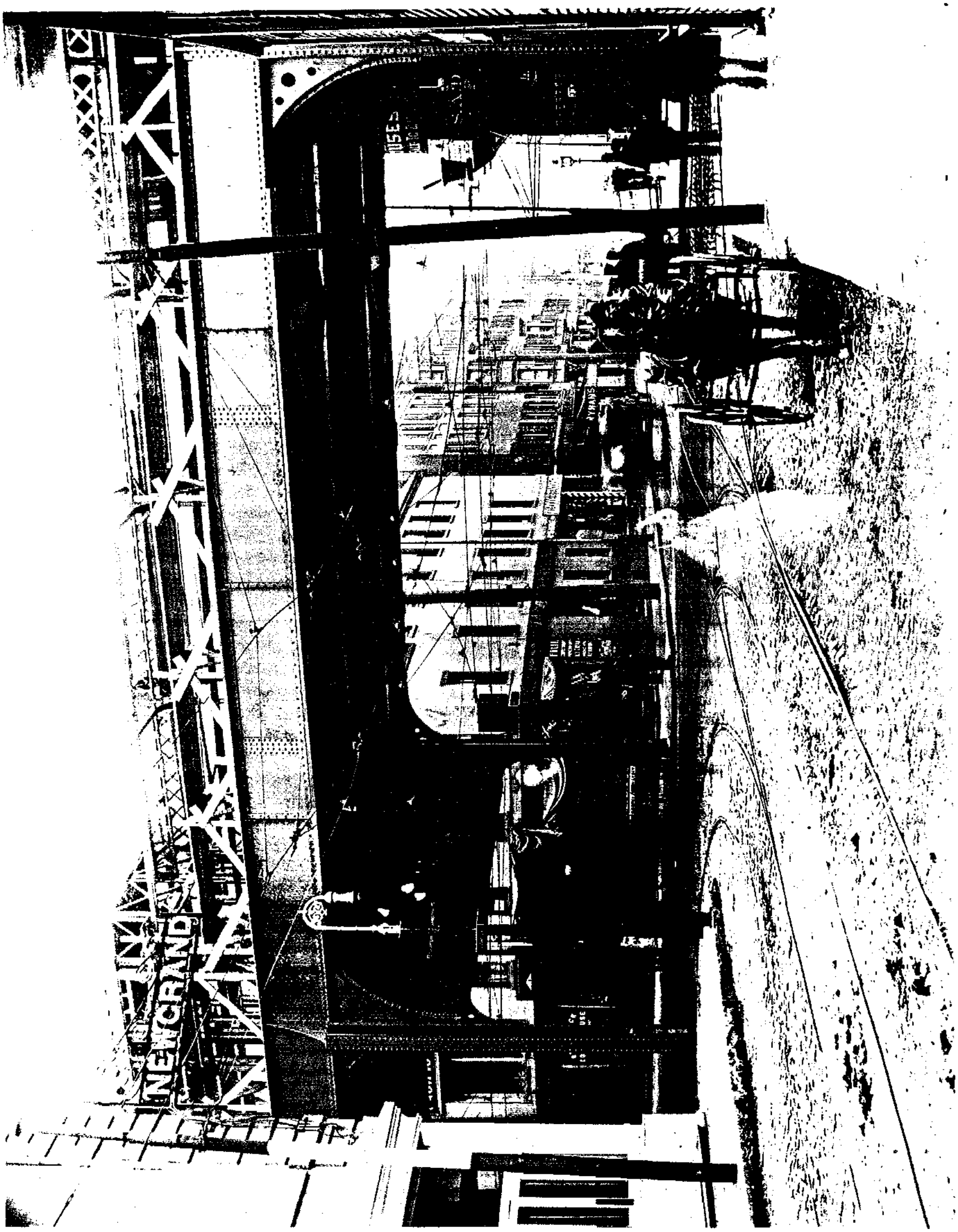

MAGEE
RANGES AND HEATERS
338
North on Wash. St. near Malden St.

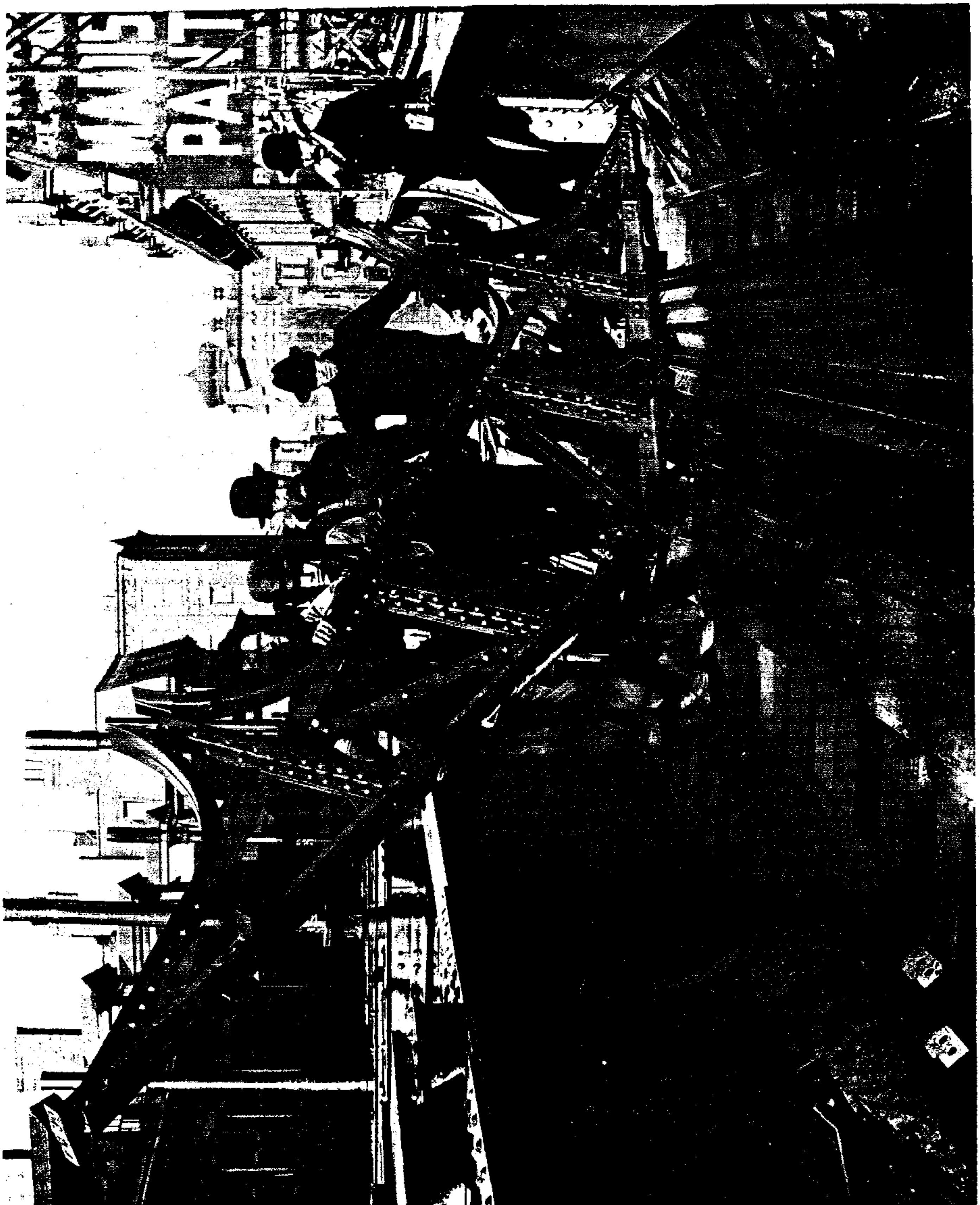

L.E.O'MEALEY, P
PLUMBING
339

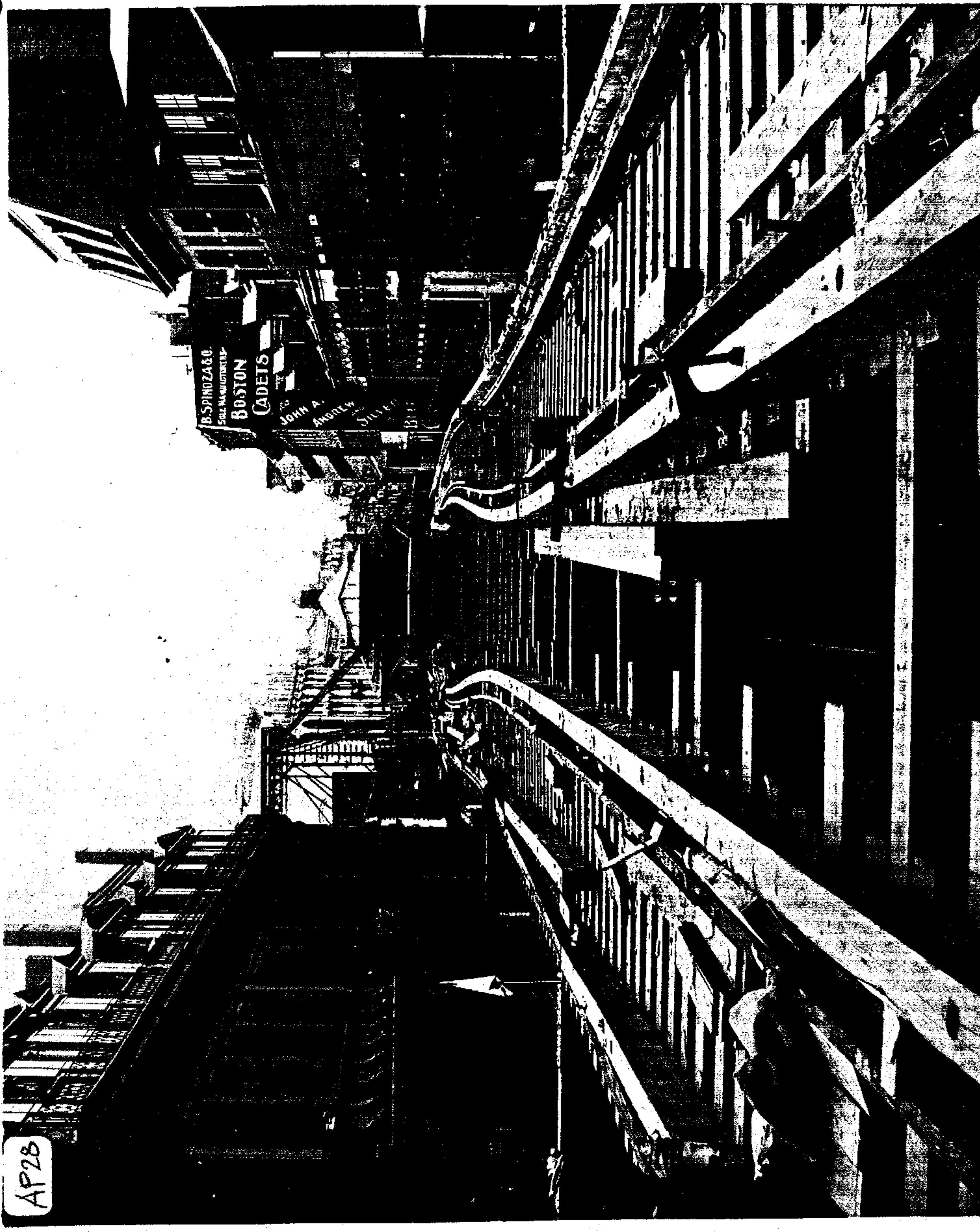

Dec 28 1899
Pneumatic Riveting Plant

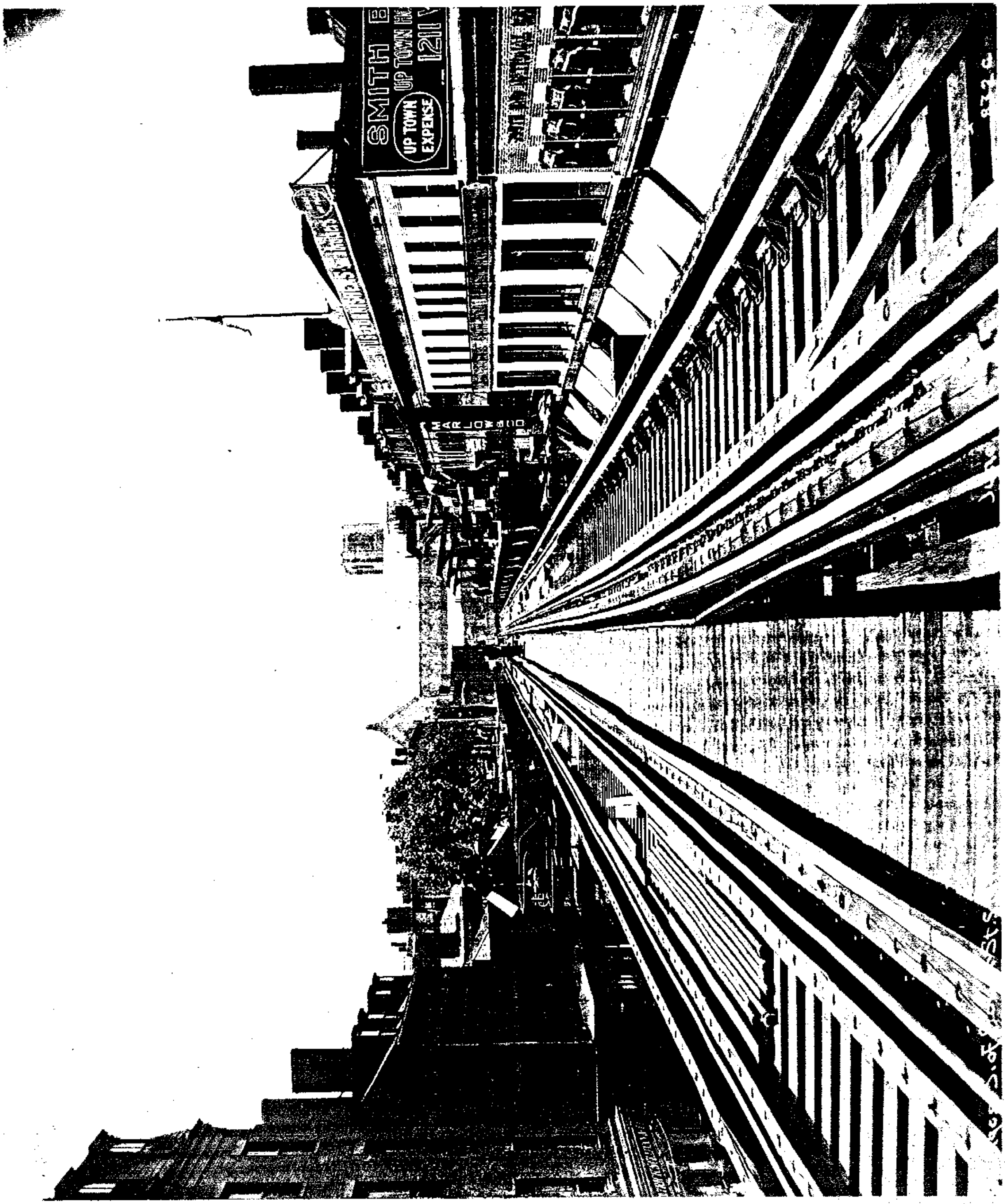

1373.
Feb.1.1901
Atlantic Av. opp.

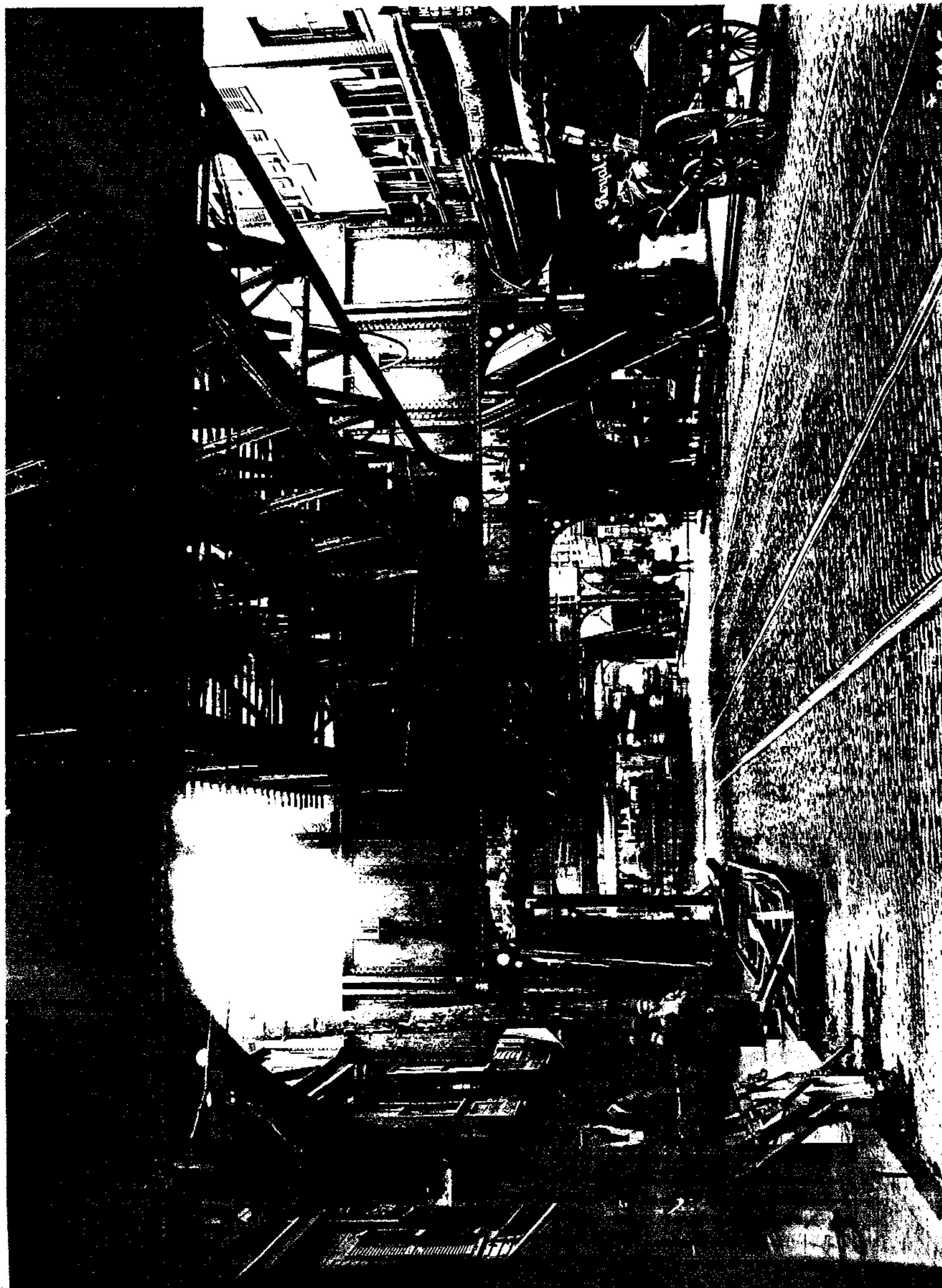

Atlantic Av. opp. Commerce St.
Feb. 2. 1901
1384

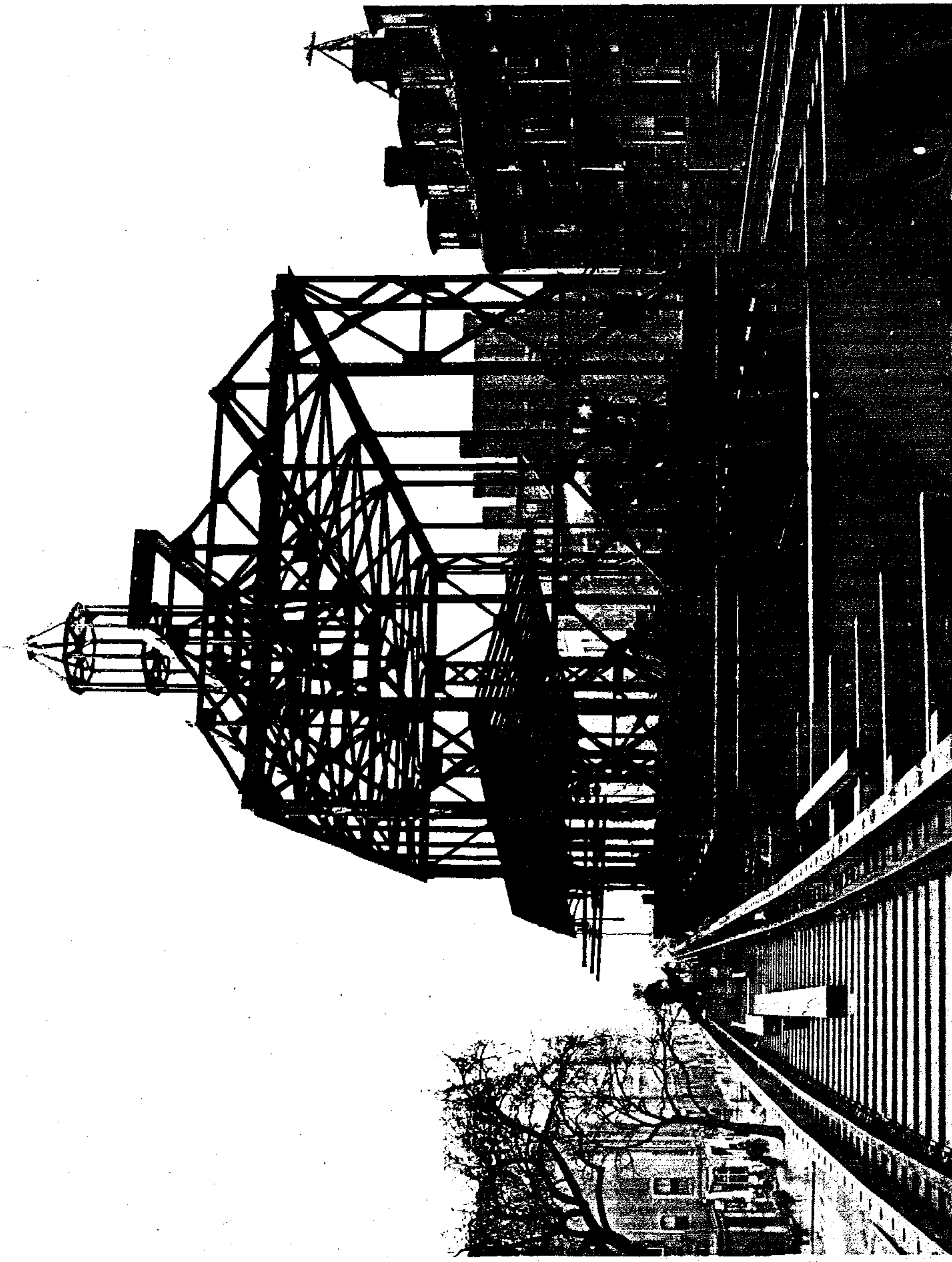

NEW GRAND

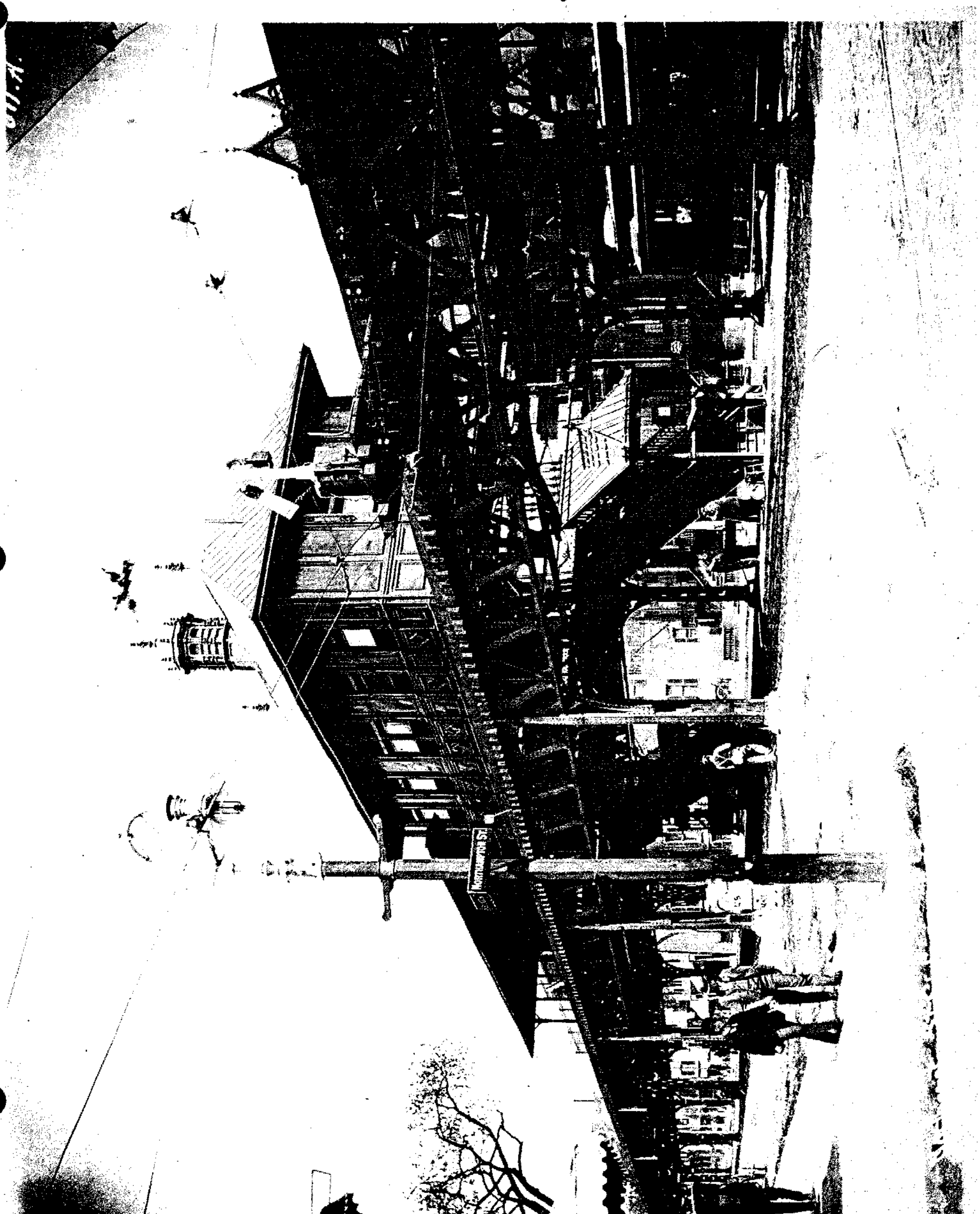


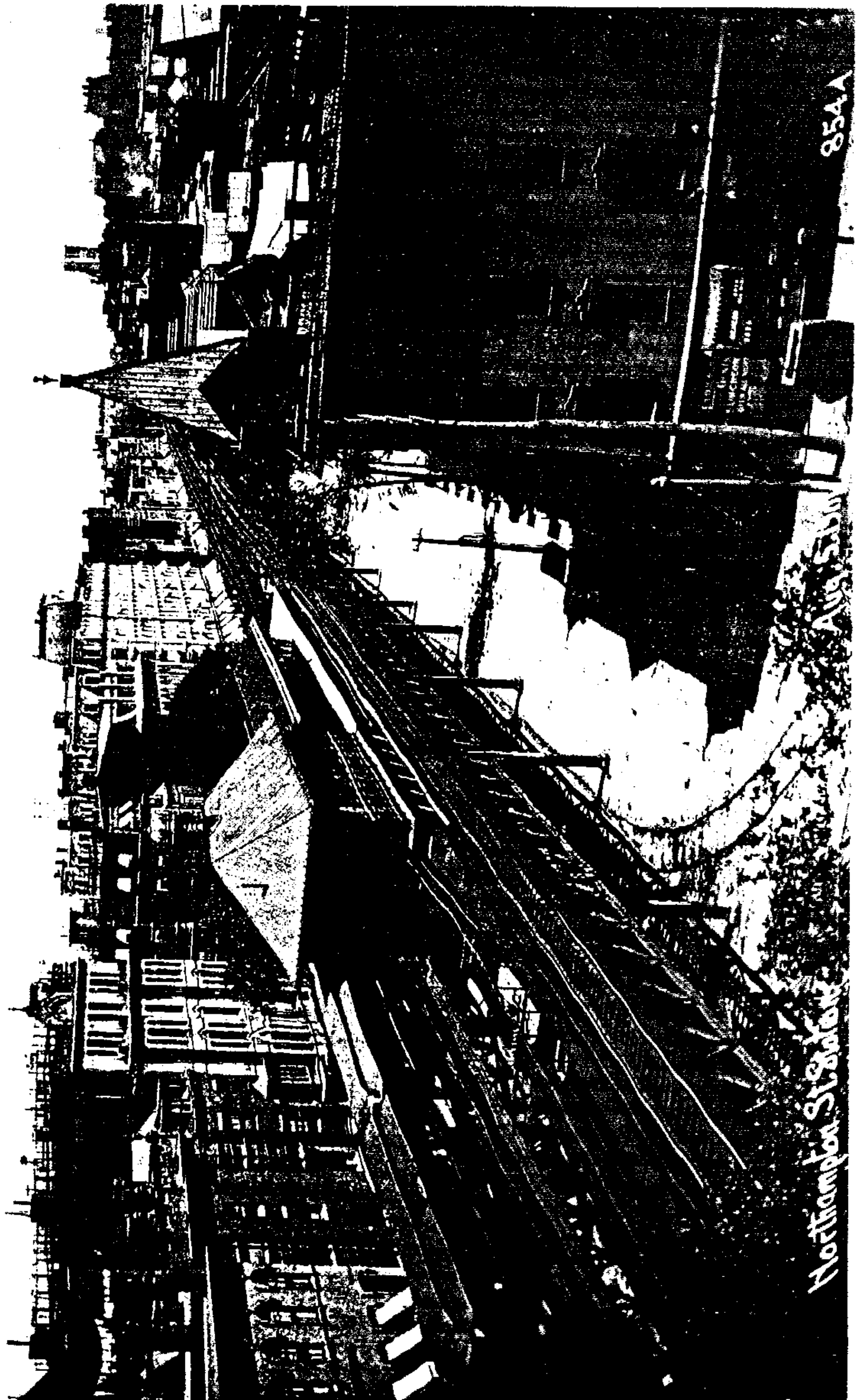

B.SPINOZA&CO.
BOSTON
CADETS
JOHN A.
ANDREW
AP28

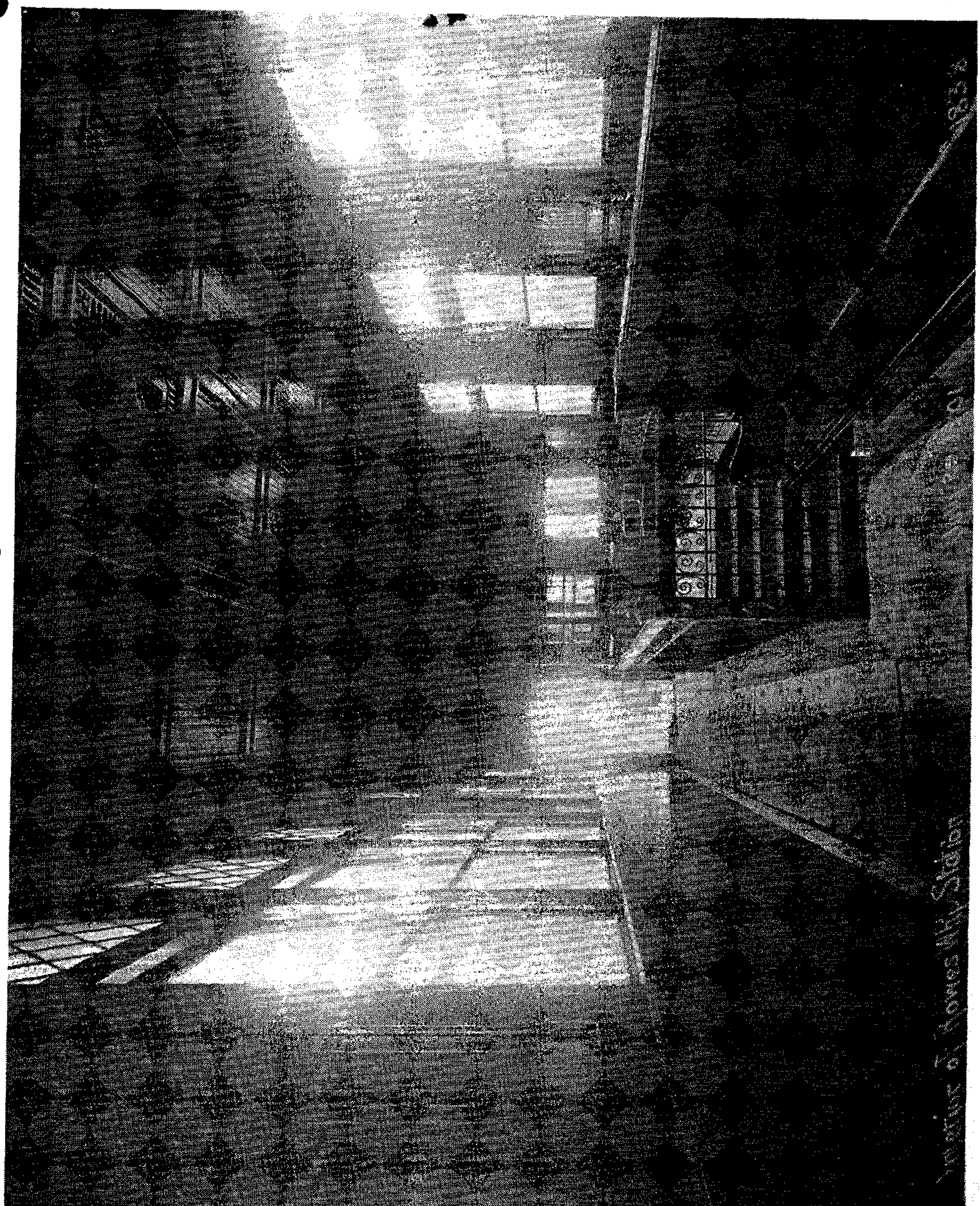


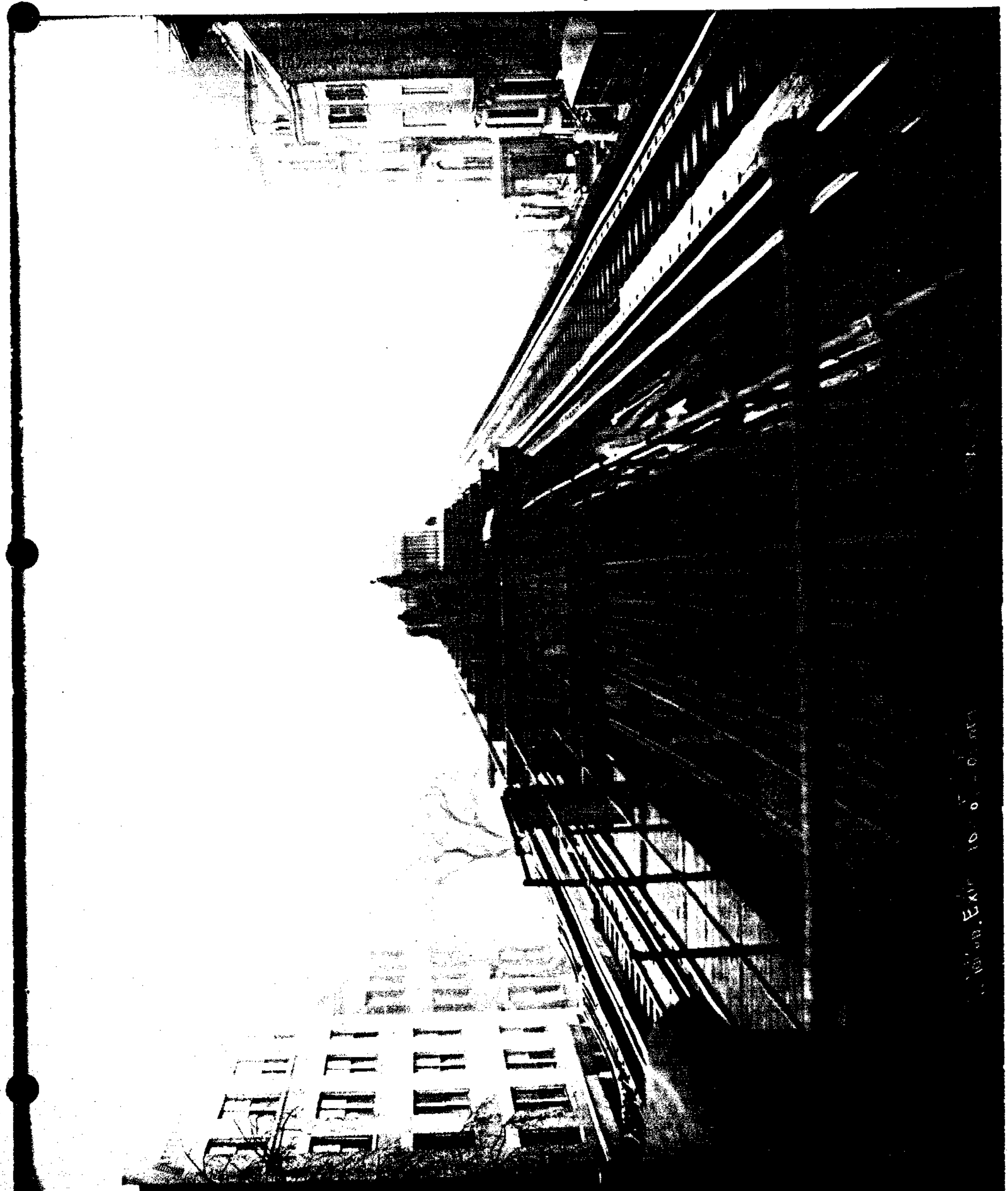


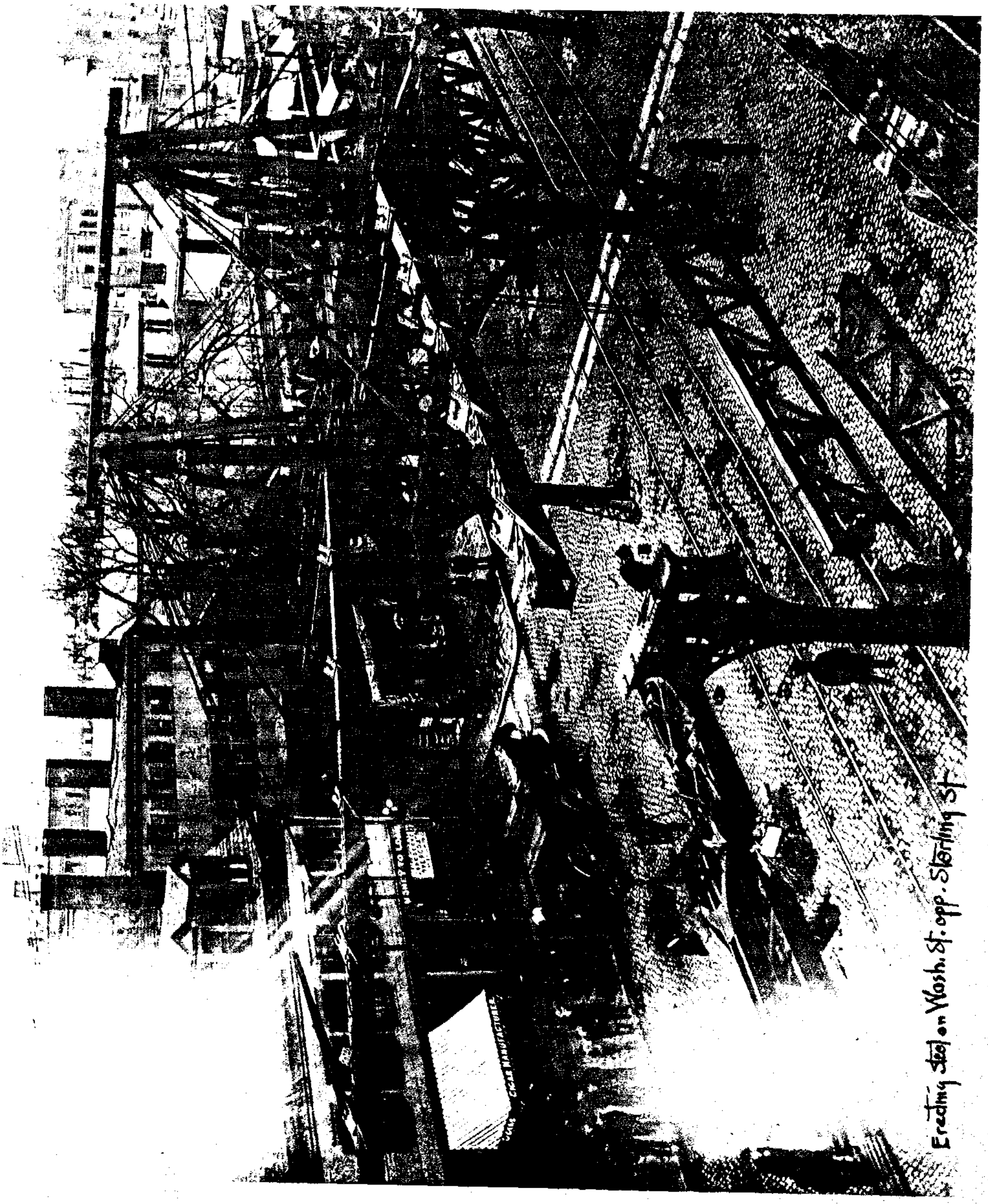





854AA
Northampton St.





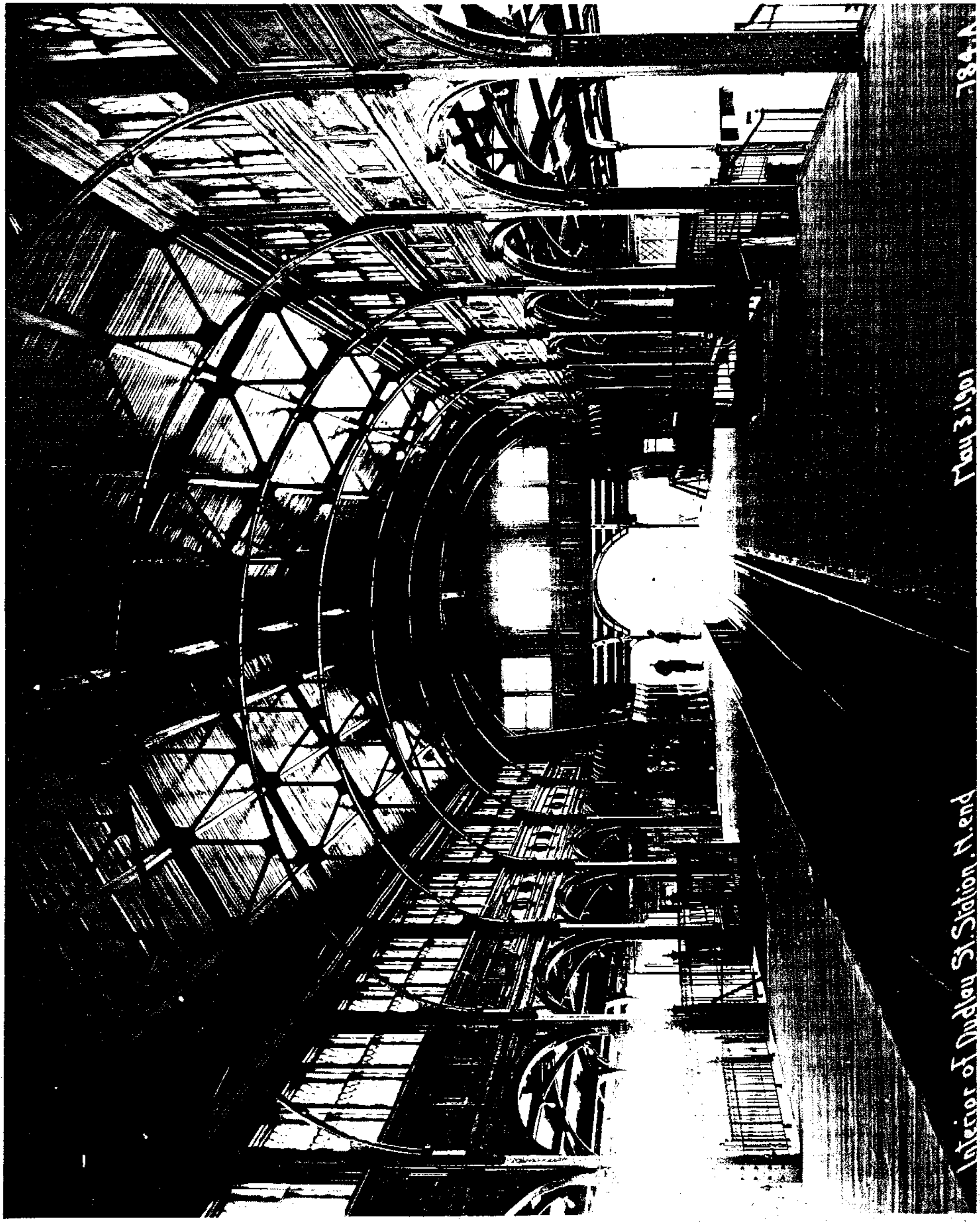


Erecting steel on Wash. St. opp. Sterling St

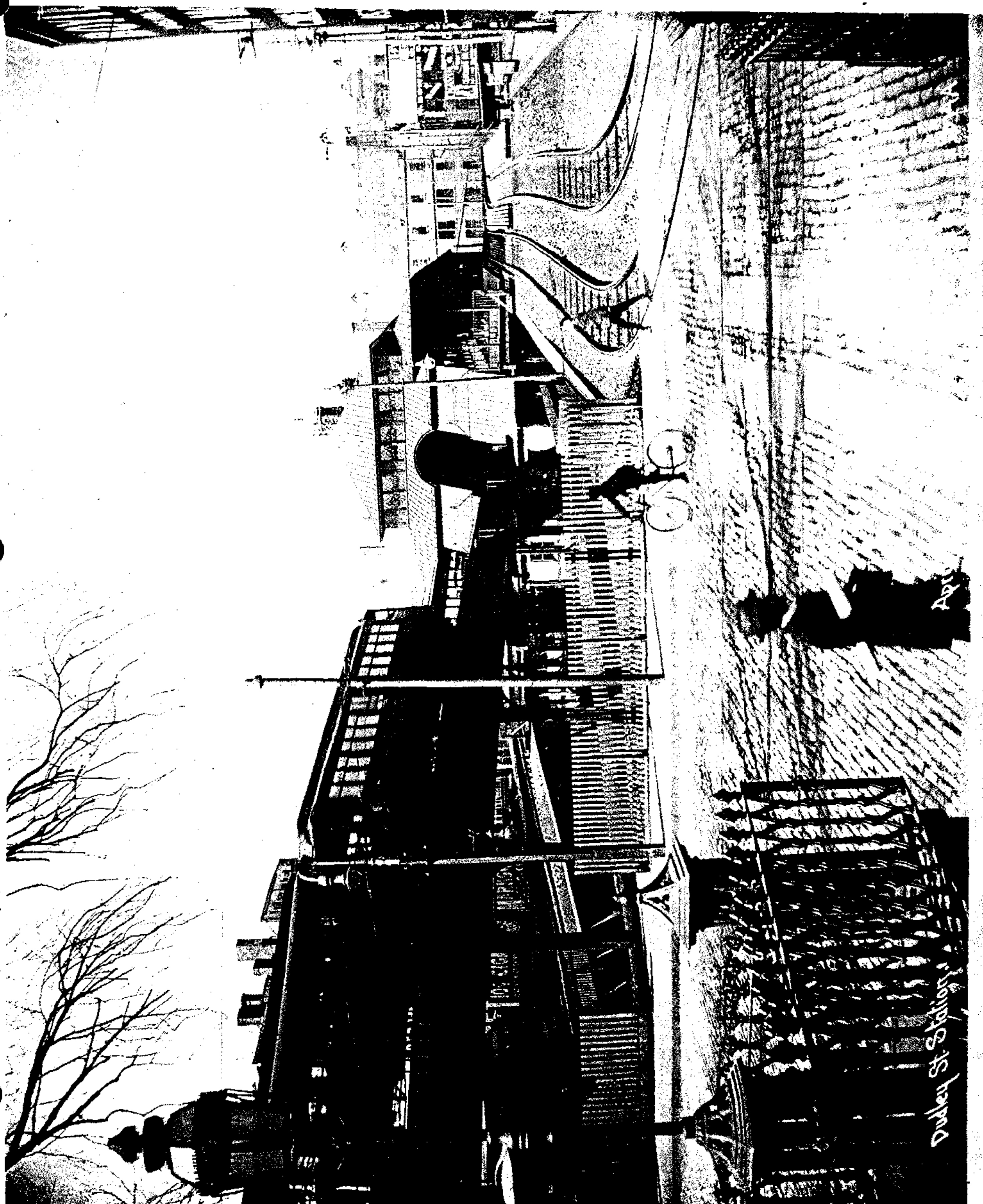

BOYLE BROS.
CREDIT CLOTHIERS
NO MONEY DOWN

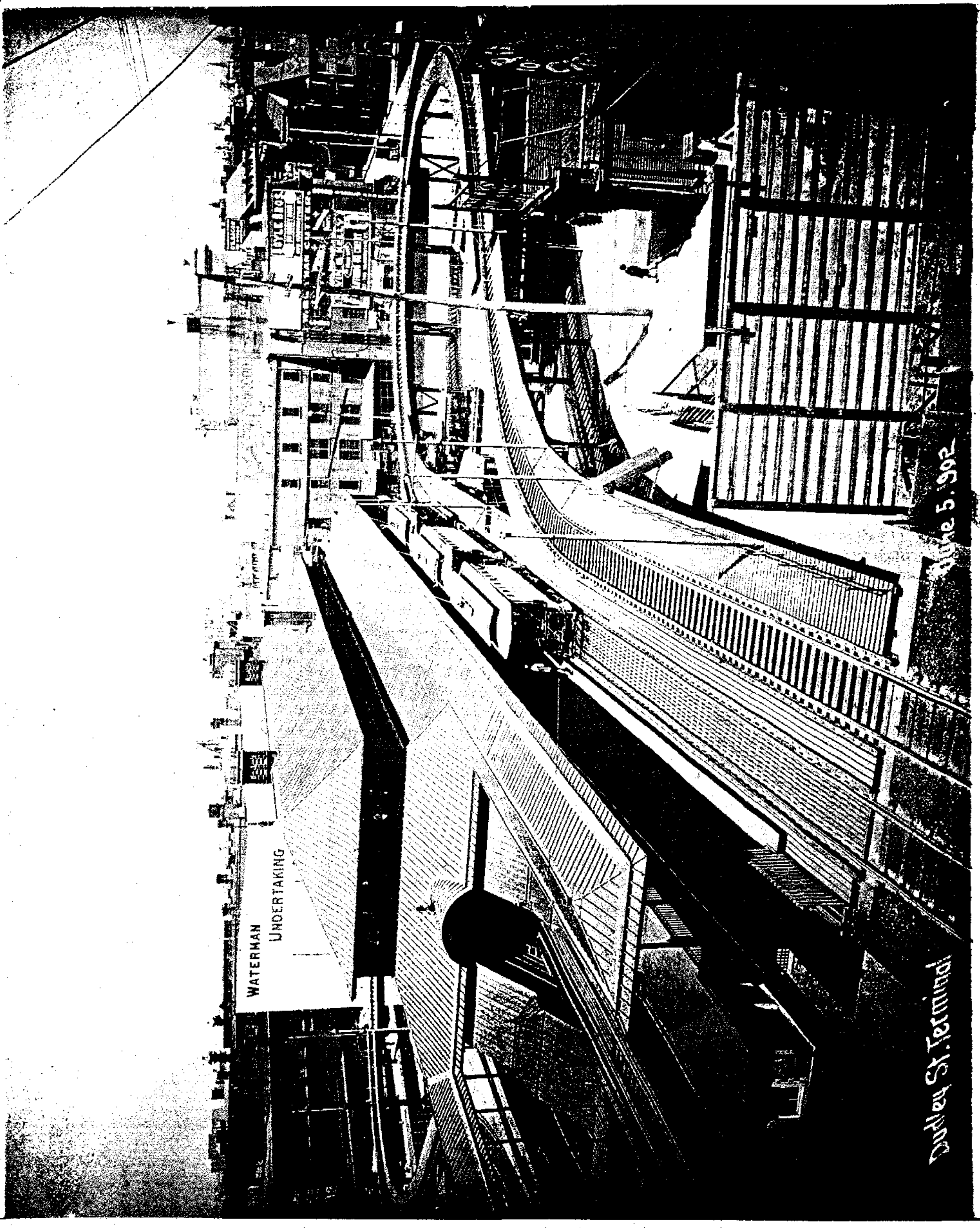

Dec. 29.1900
Dudley St. Station


Dudley St. Station, Waiting room
Dec. 29, 1900

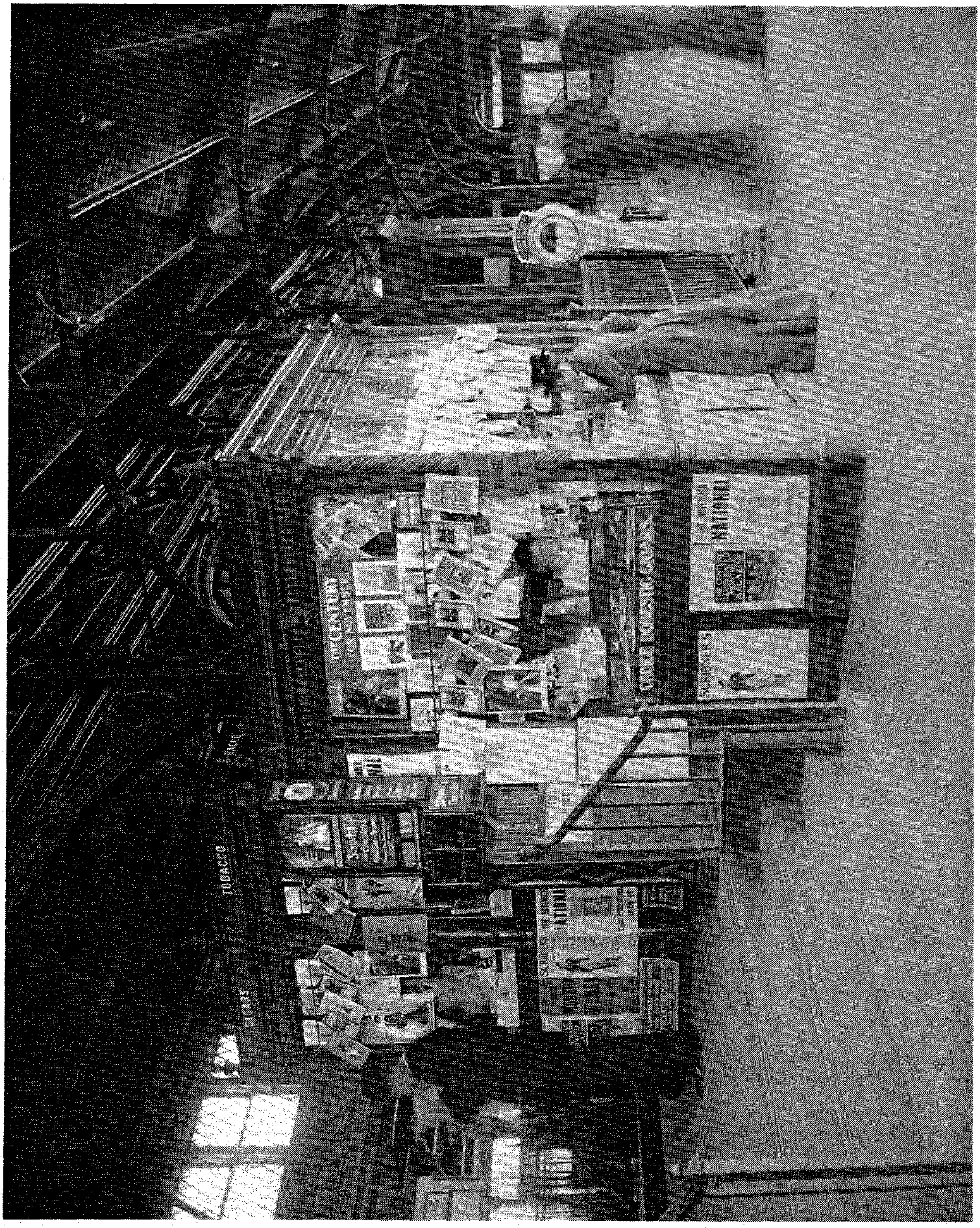

Interior of Dudley St. Station. N. end
May 3.1901

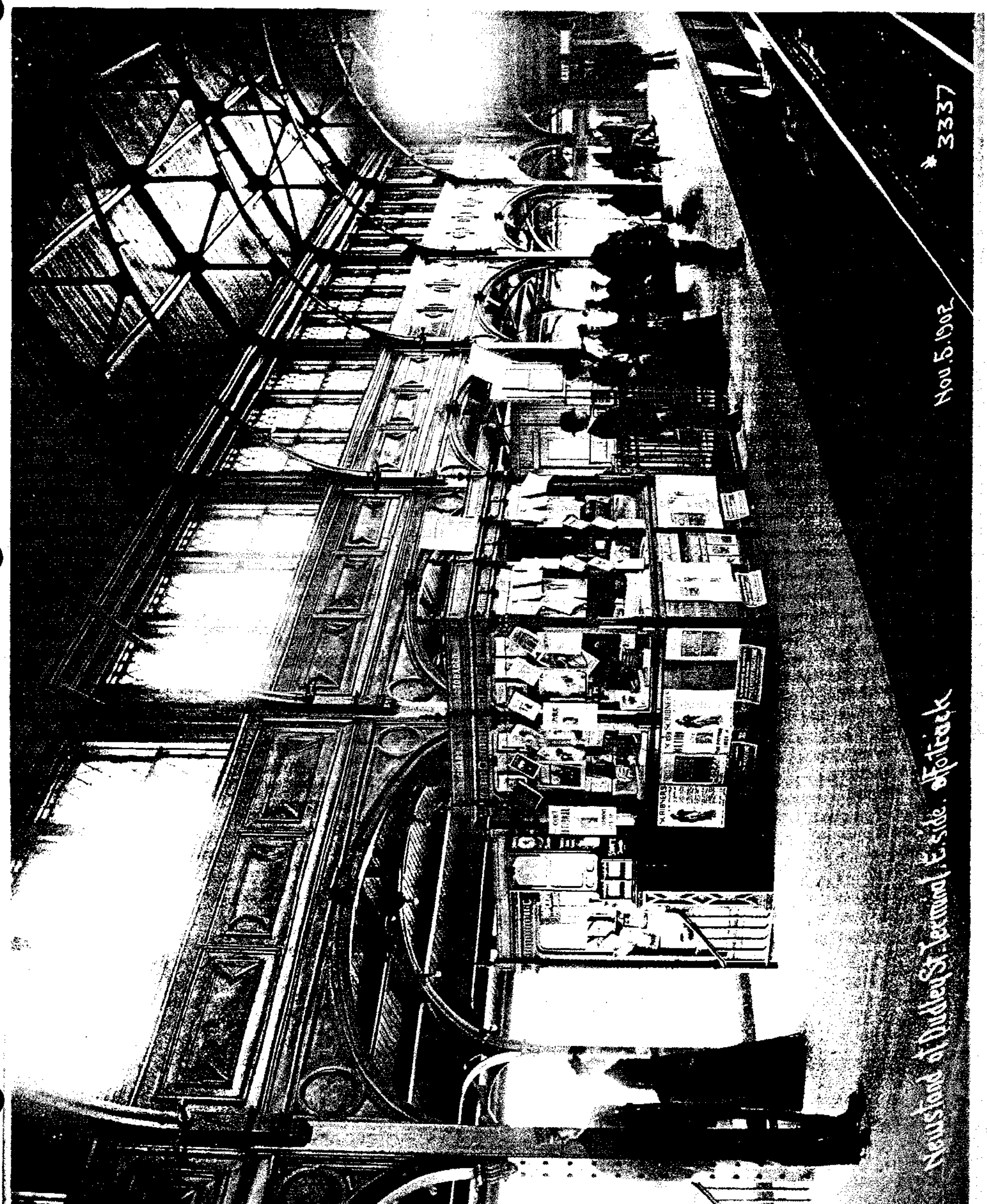

880A
Oct. 25. 1901
Dudley St. Terminal. E. side
UNDERTAKERS
COLONIAL

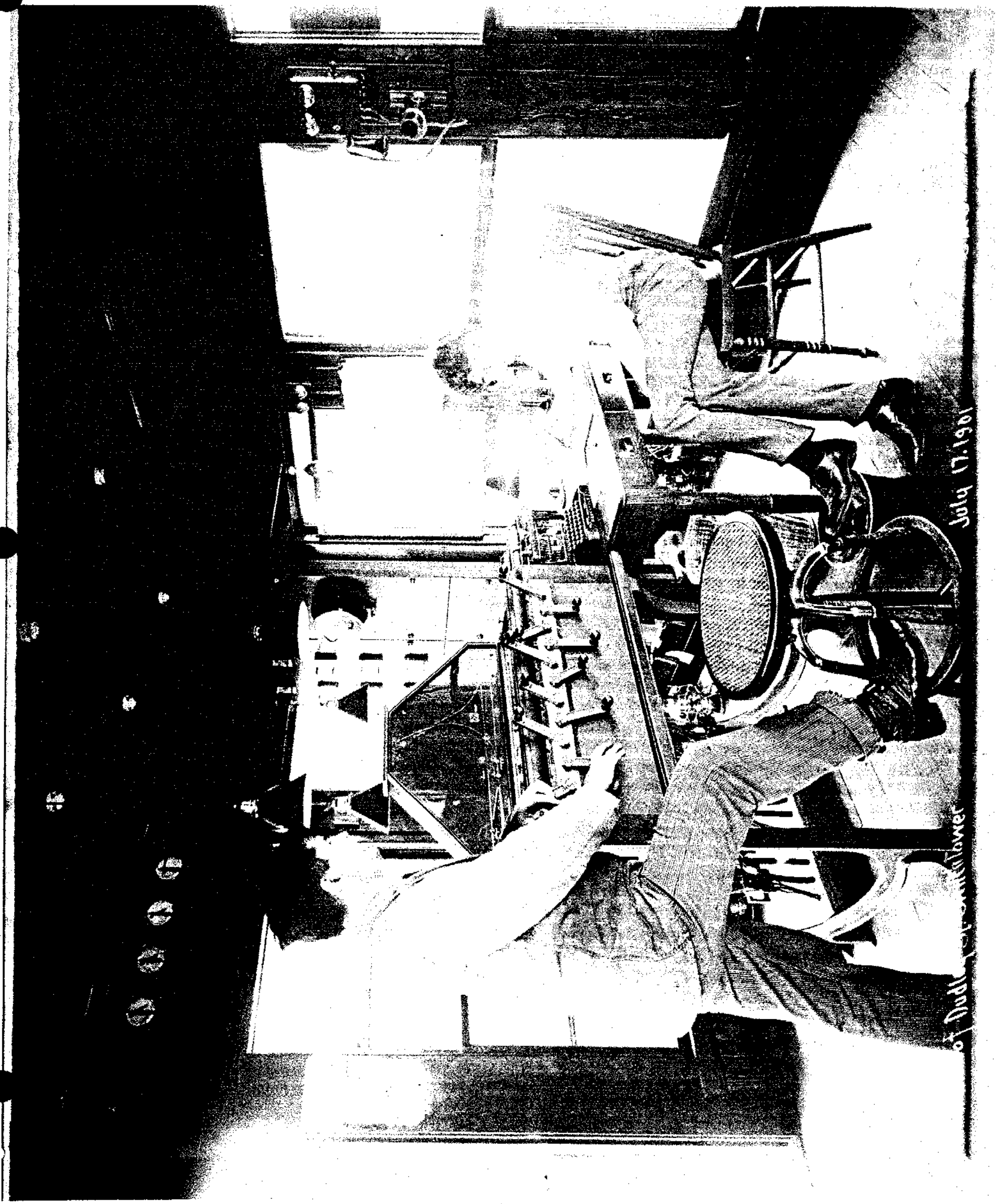

Dudley St. Station

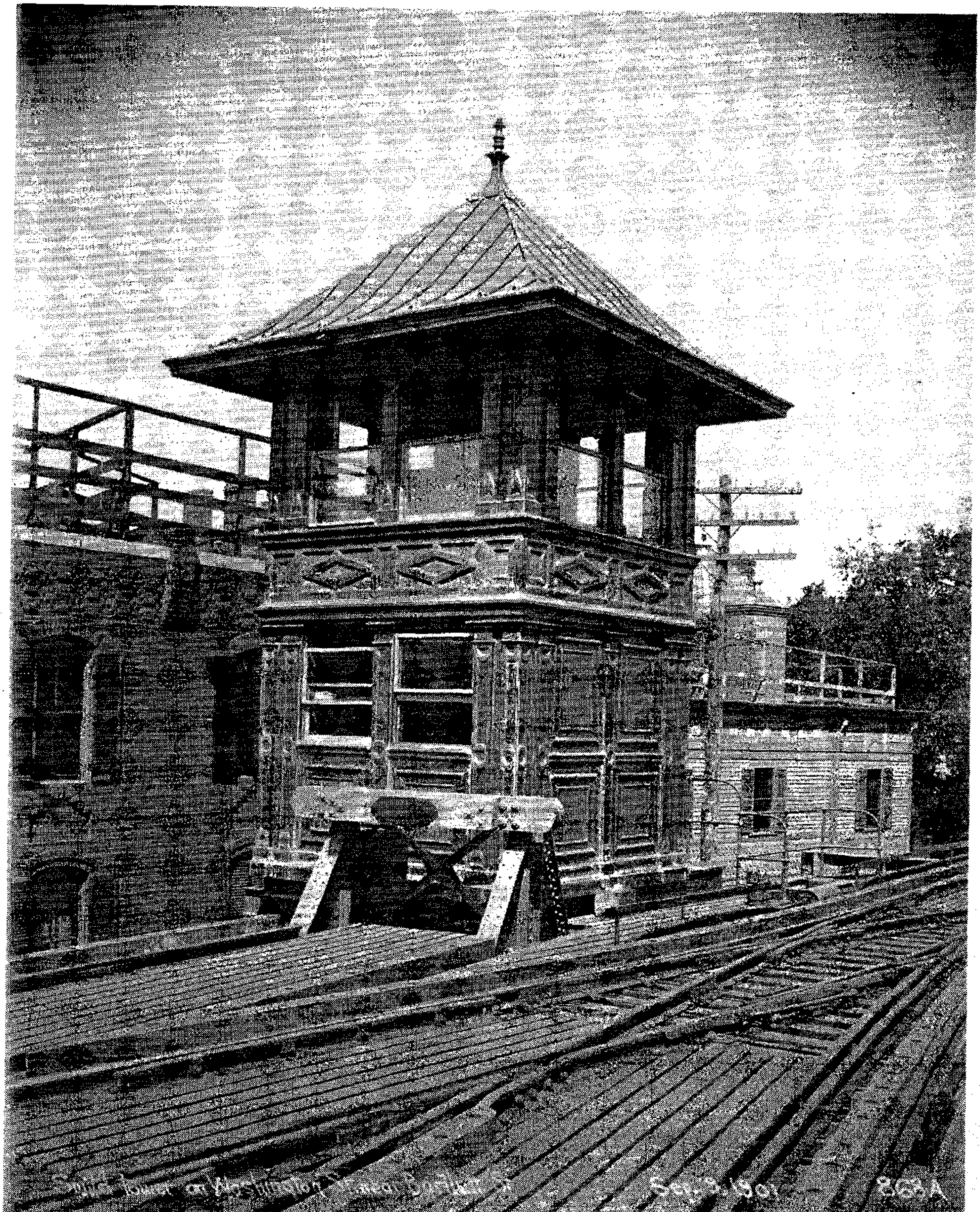

WATERMAN
UNDERTAKING
Dudley St. Terminal.
June 5. 902

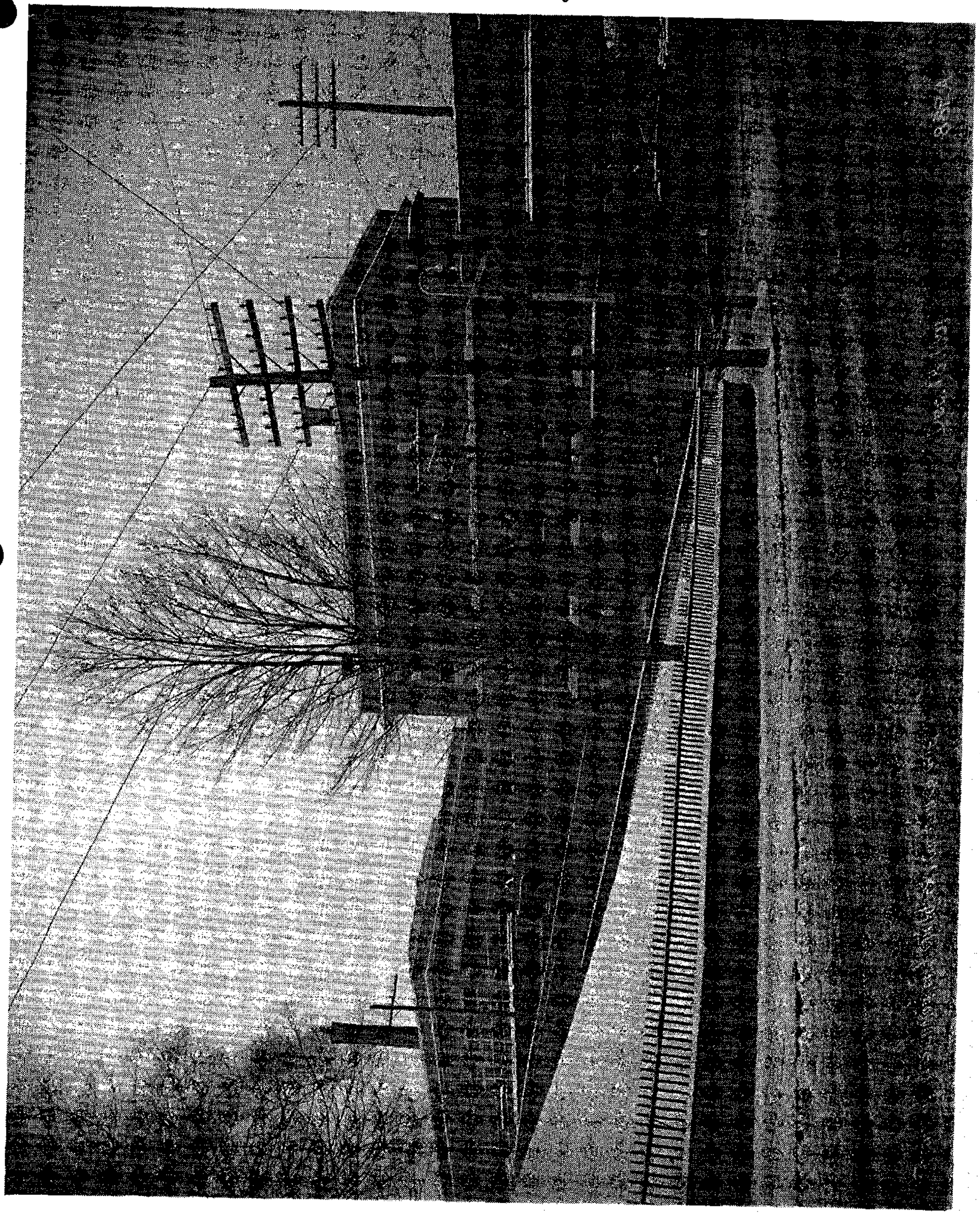

Dudley St. Terminal

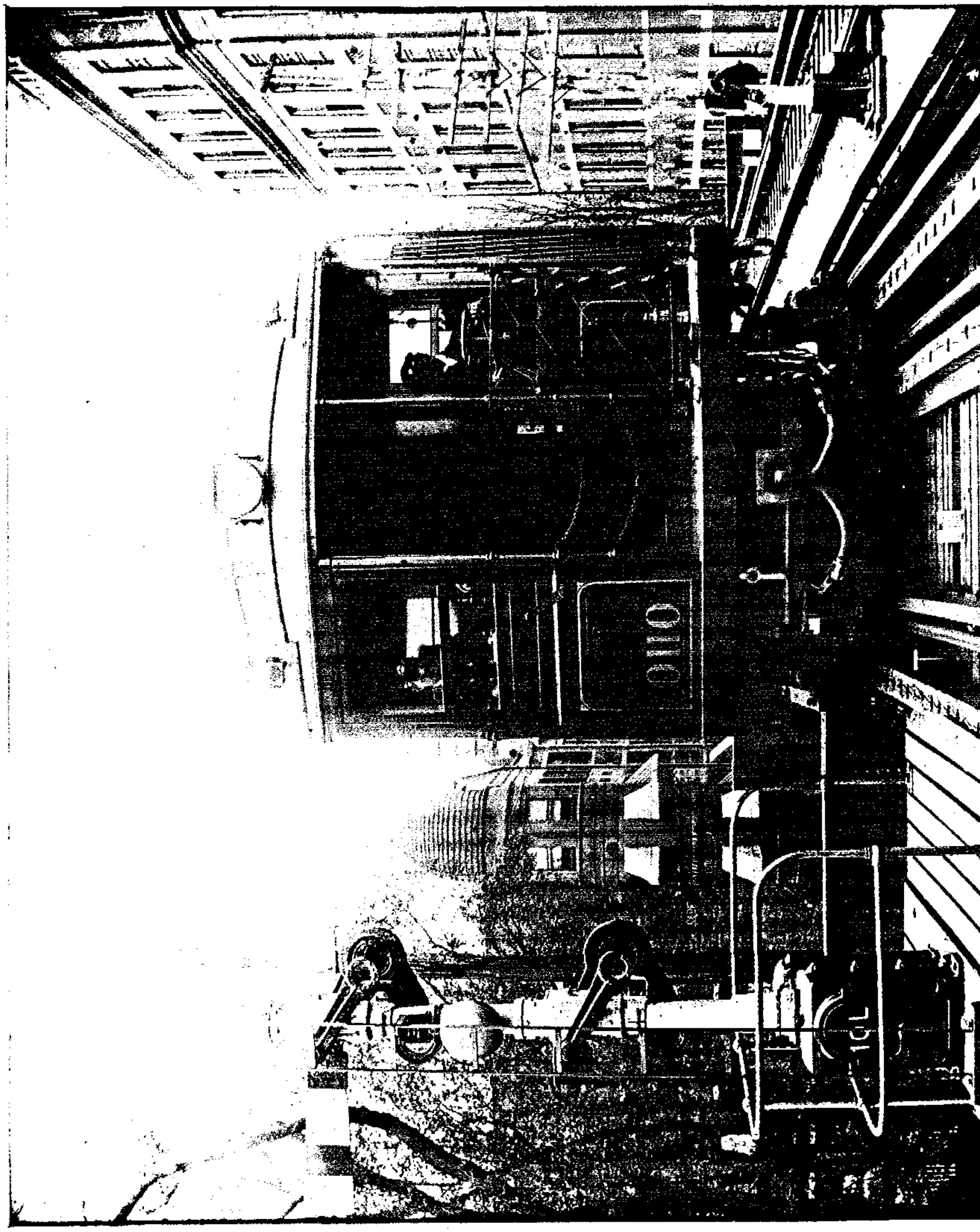

TOBACCO

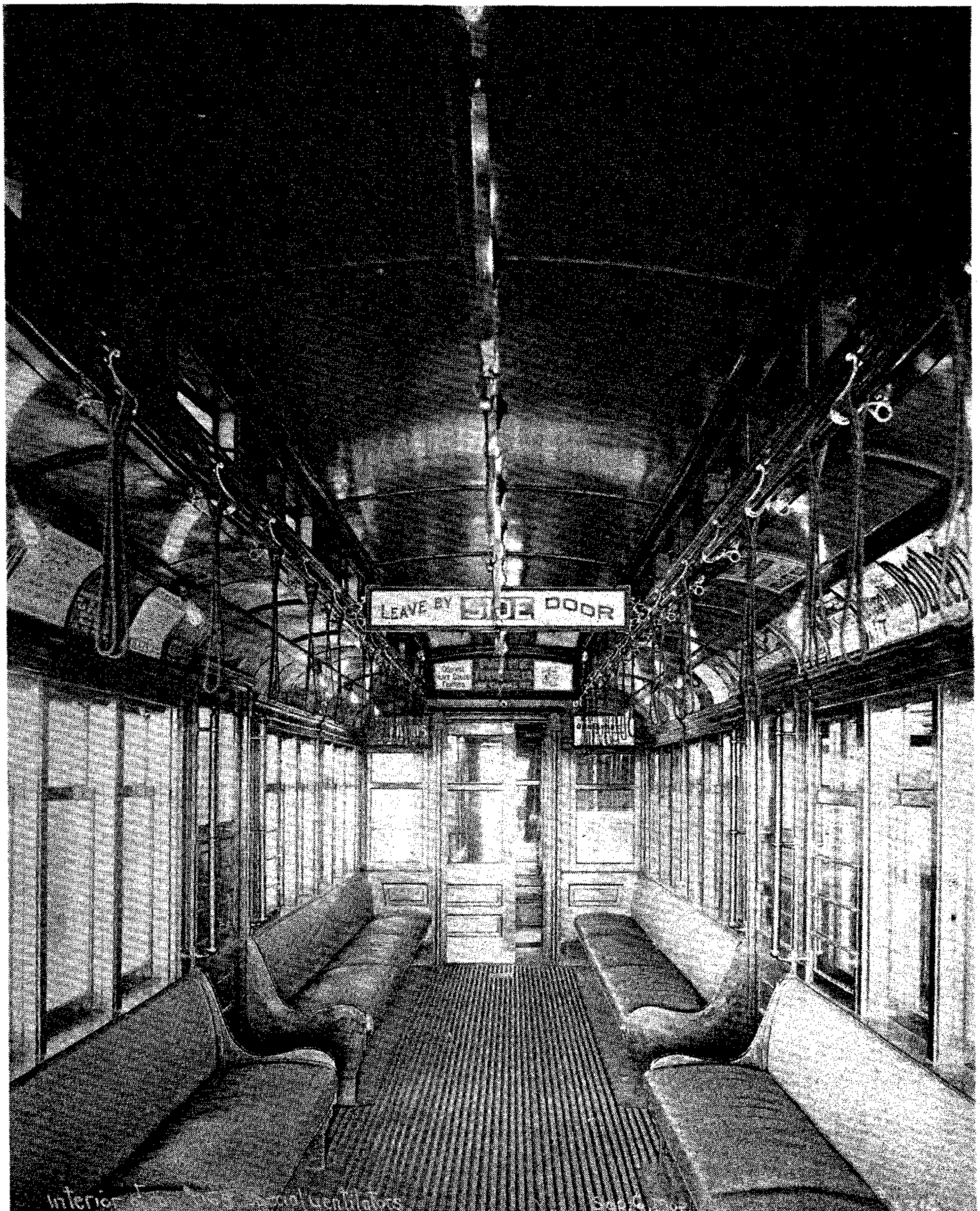

Newsstand at Dudley St. Terminal, E. side.
Nov. 5. 1902
3337


July 17.1901

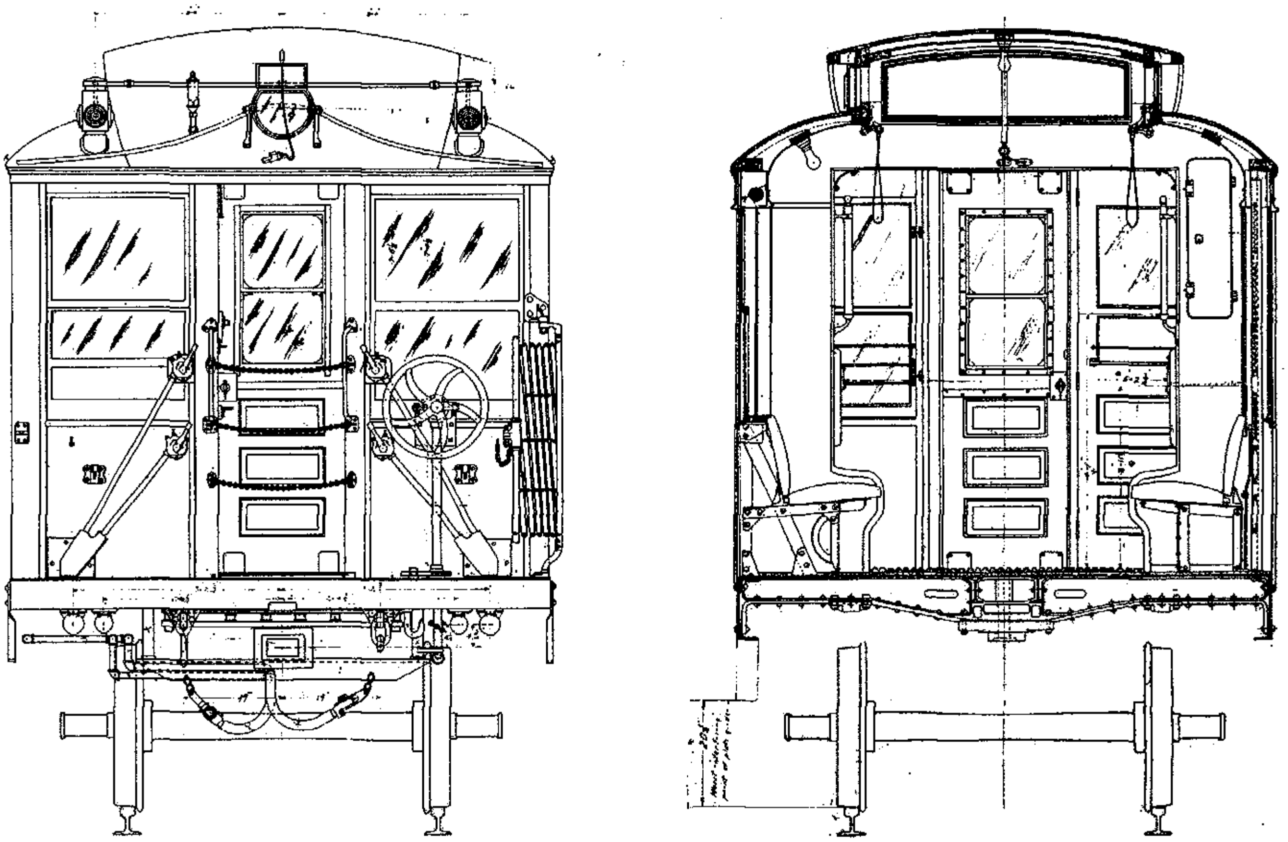




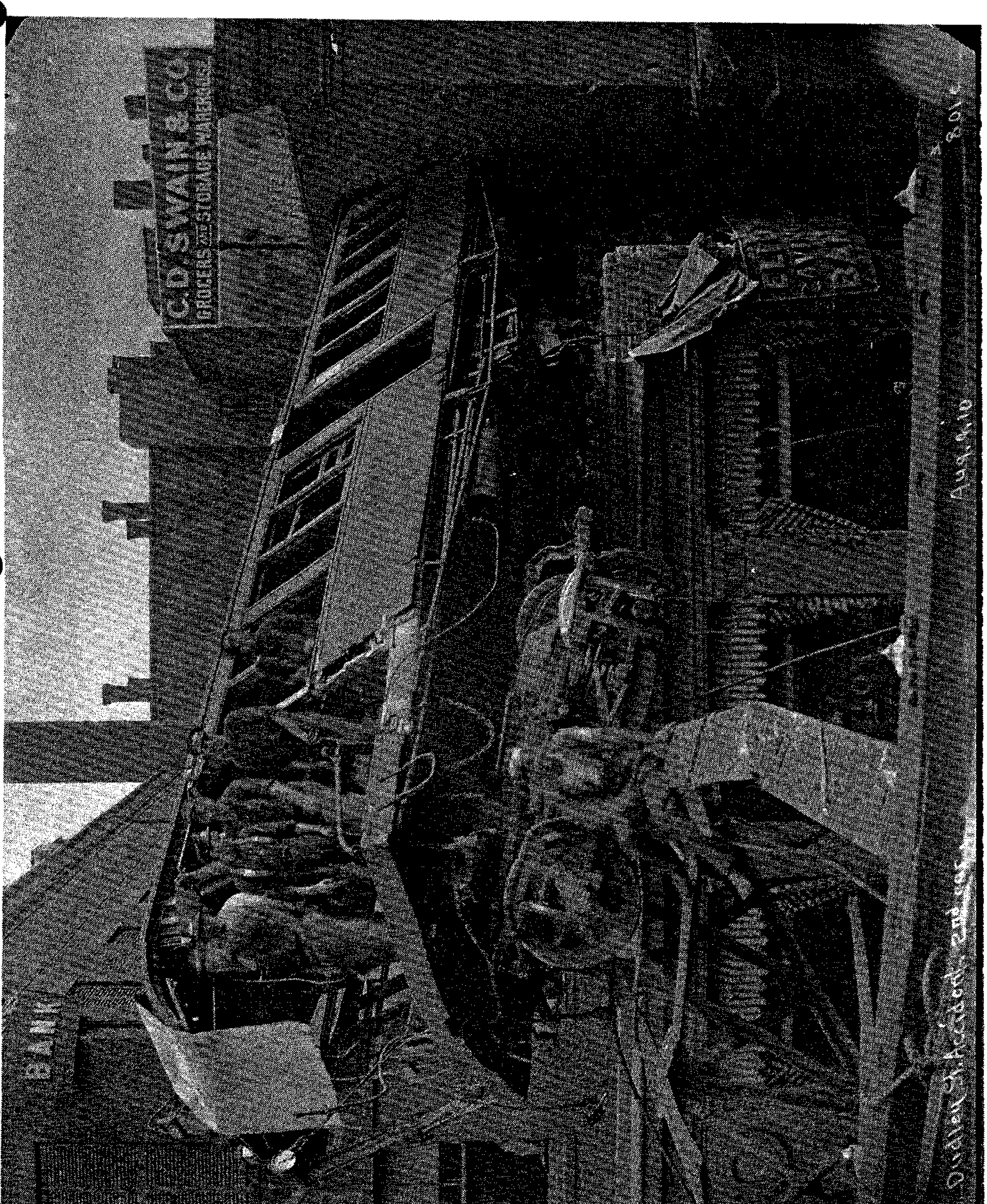

0110

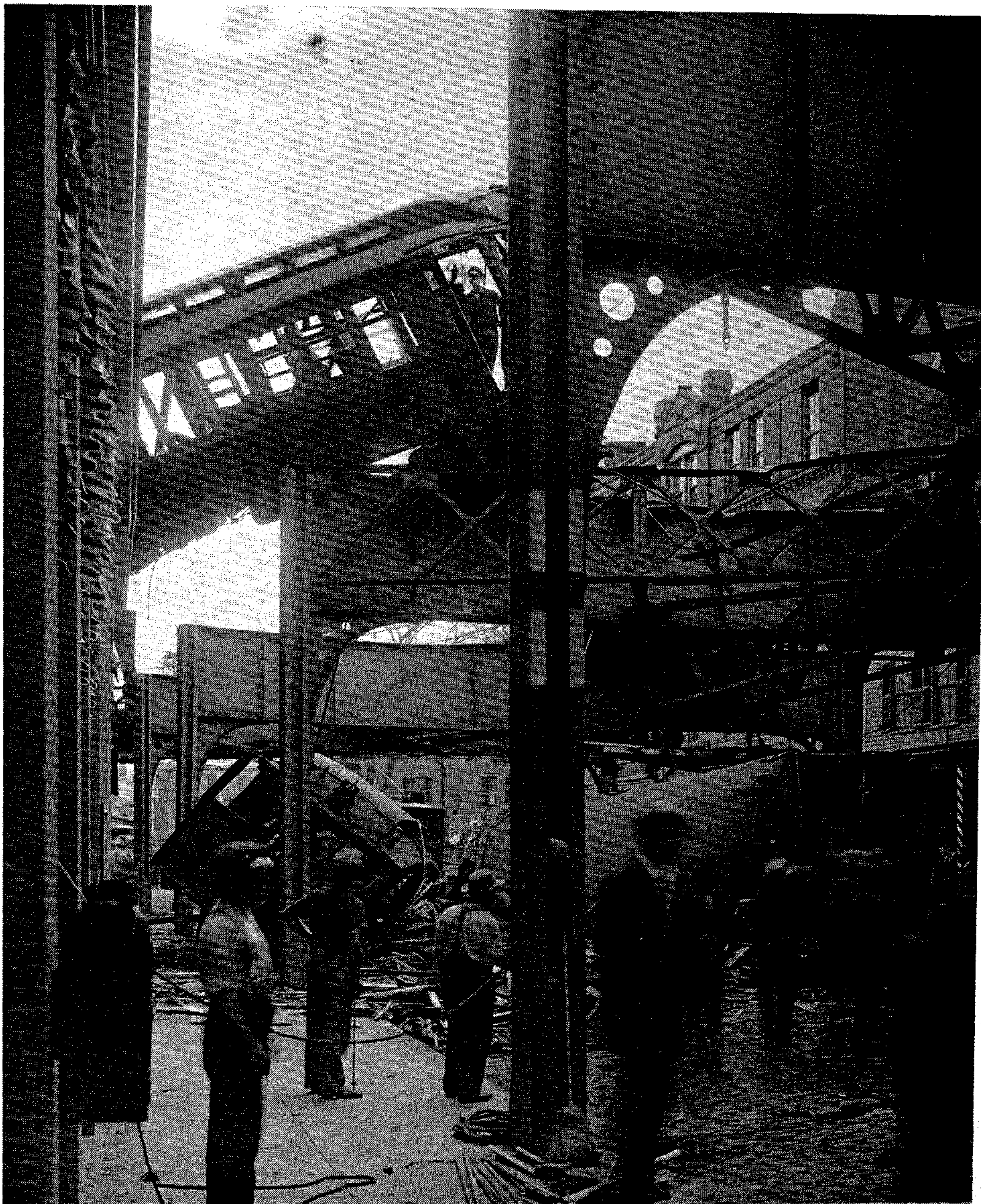

LEAVE BY
DOOR
Interior
ventilators

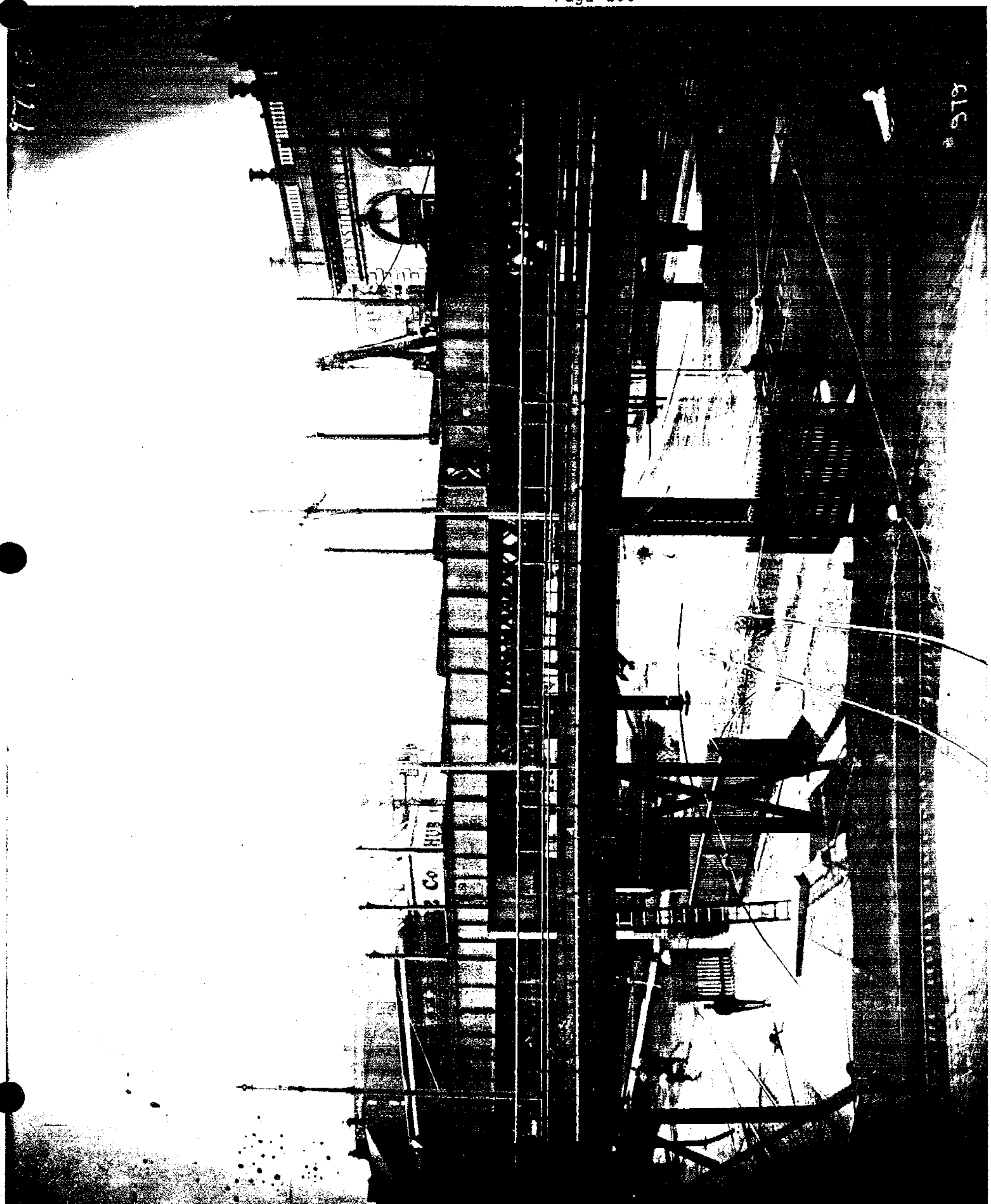

31.
25901.



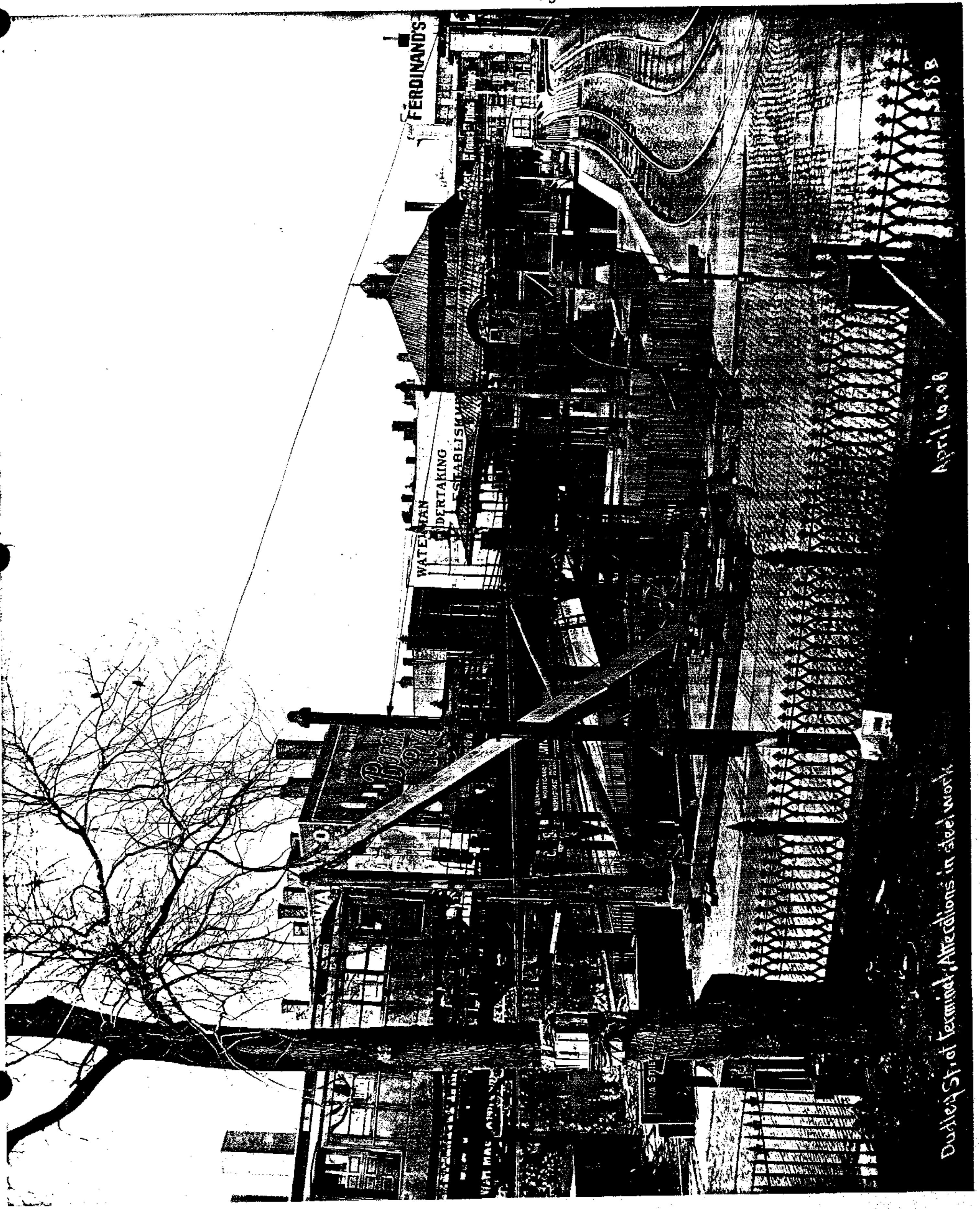
END ELEVATION-CAR
NO 3 ELEVATED


C.D. SWAIN & CO.
BANK


Wreck at Dudley St Aug 4 1910 PHOTO NO

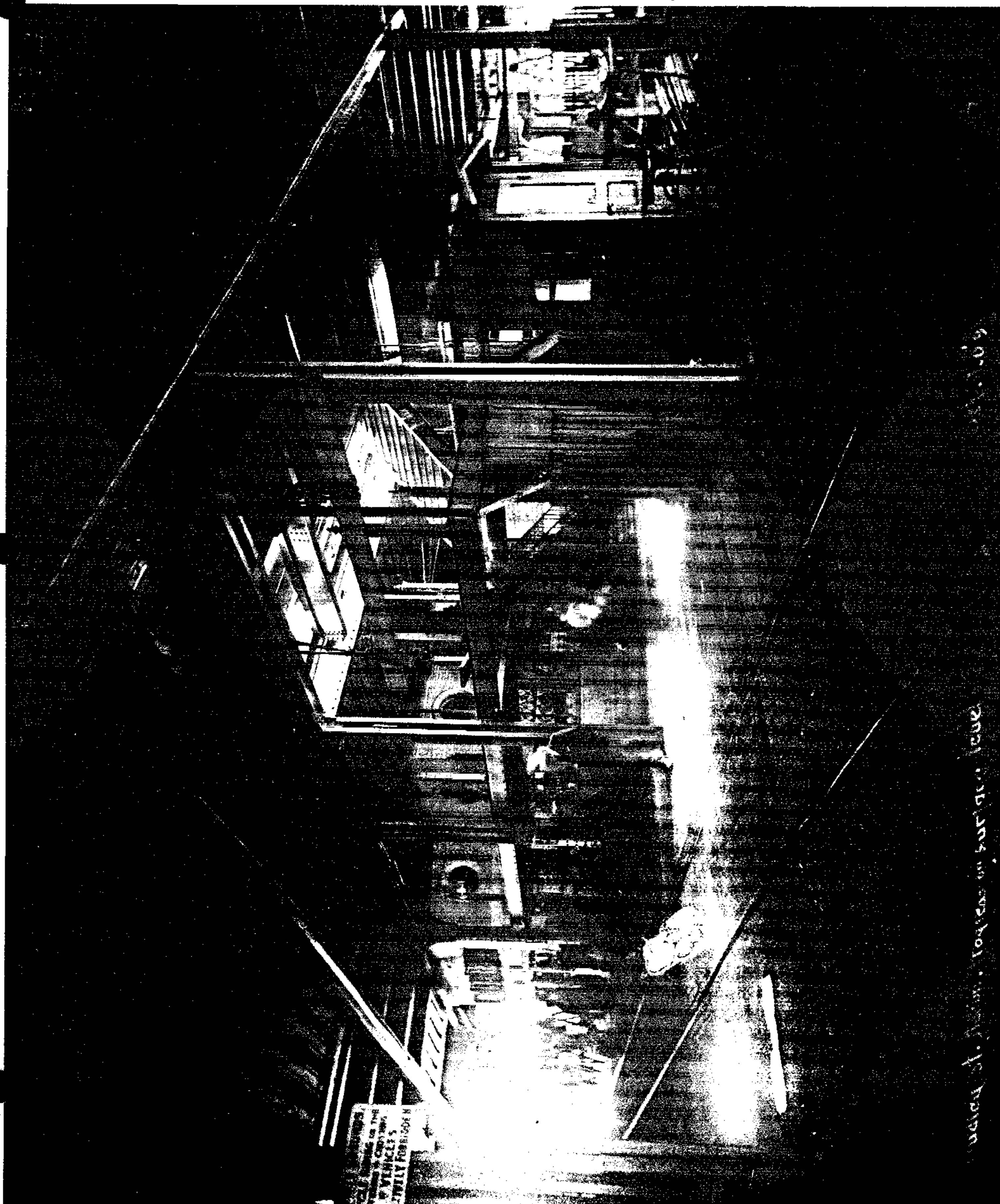


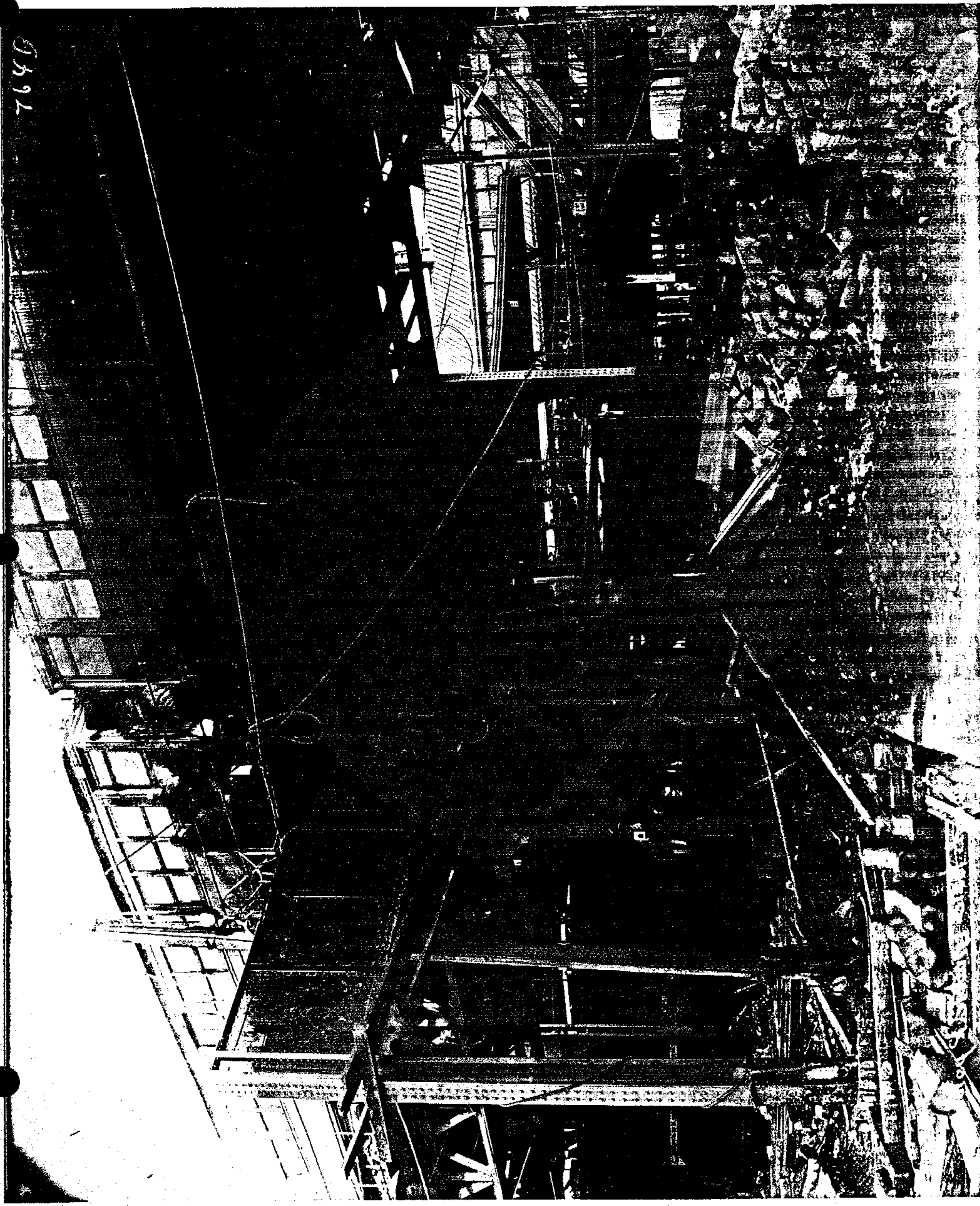

GRIST MILL
COFFEE
NERVES

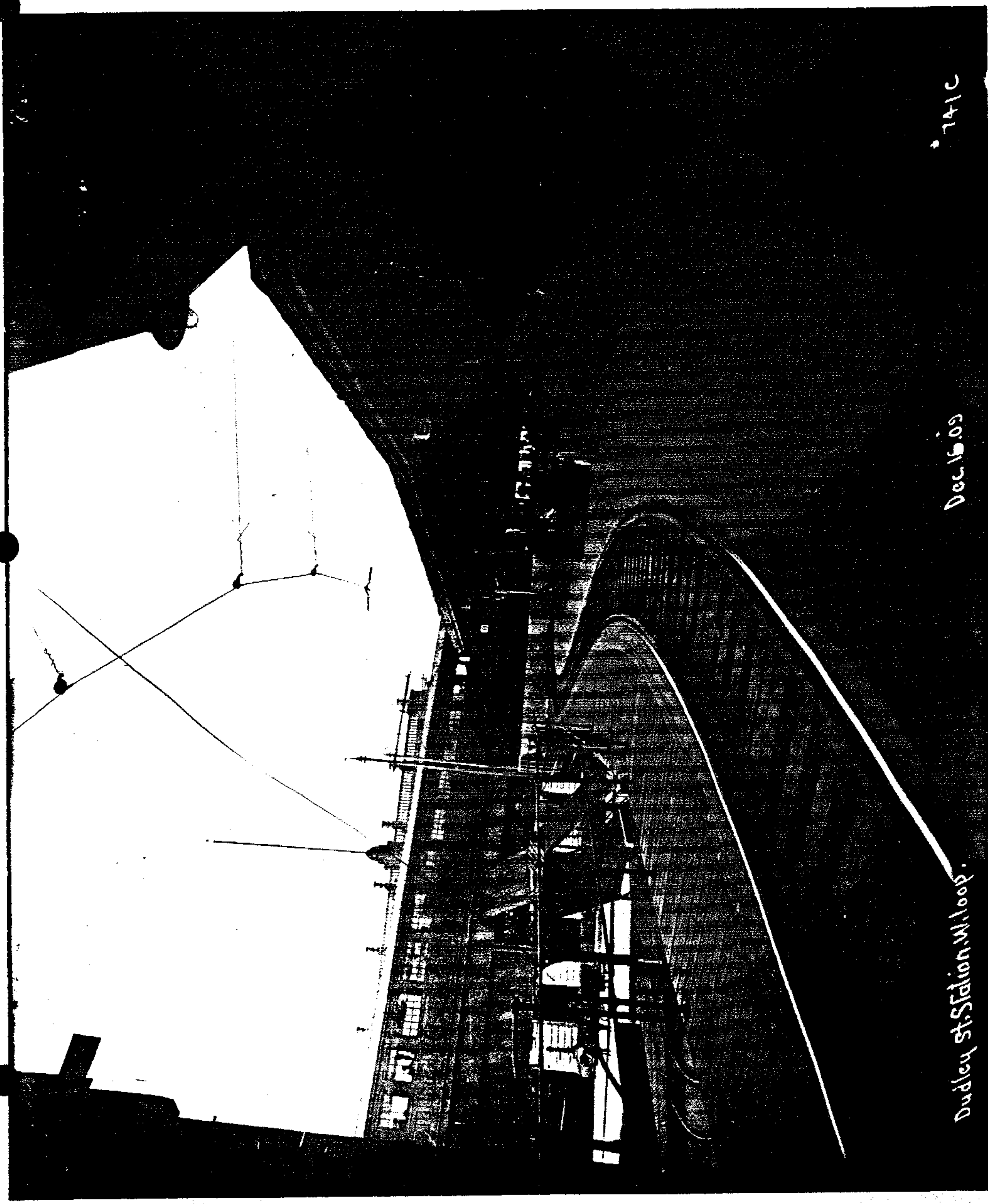


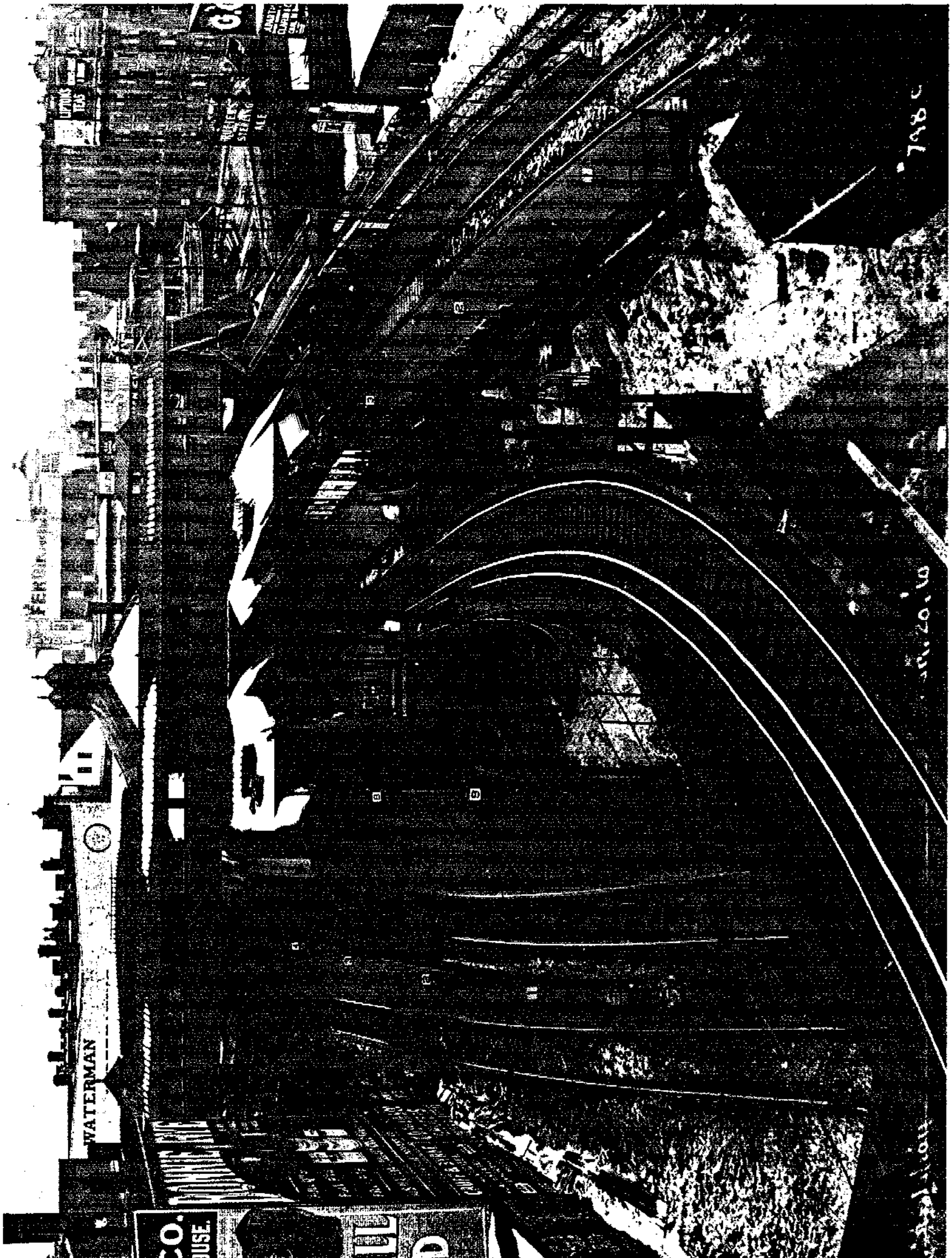
Dudley St. terminal, Alterations in steel work April 10, 08 5598 B

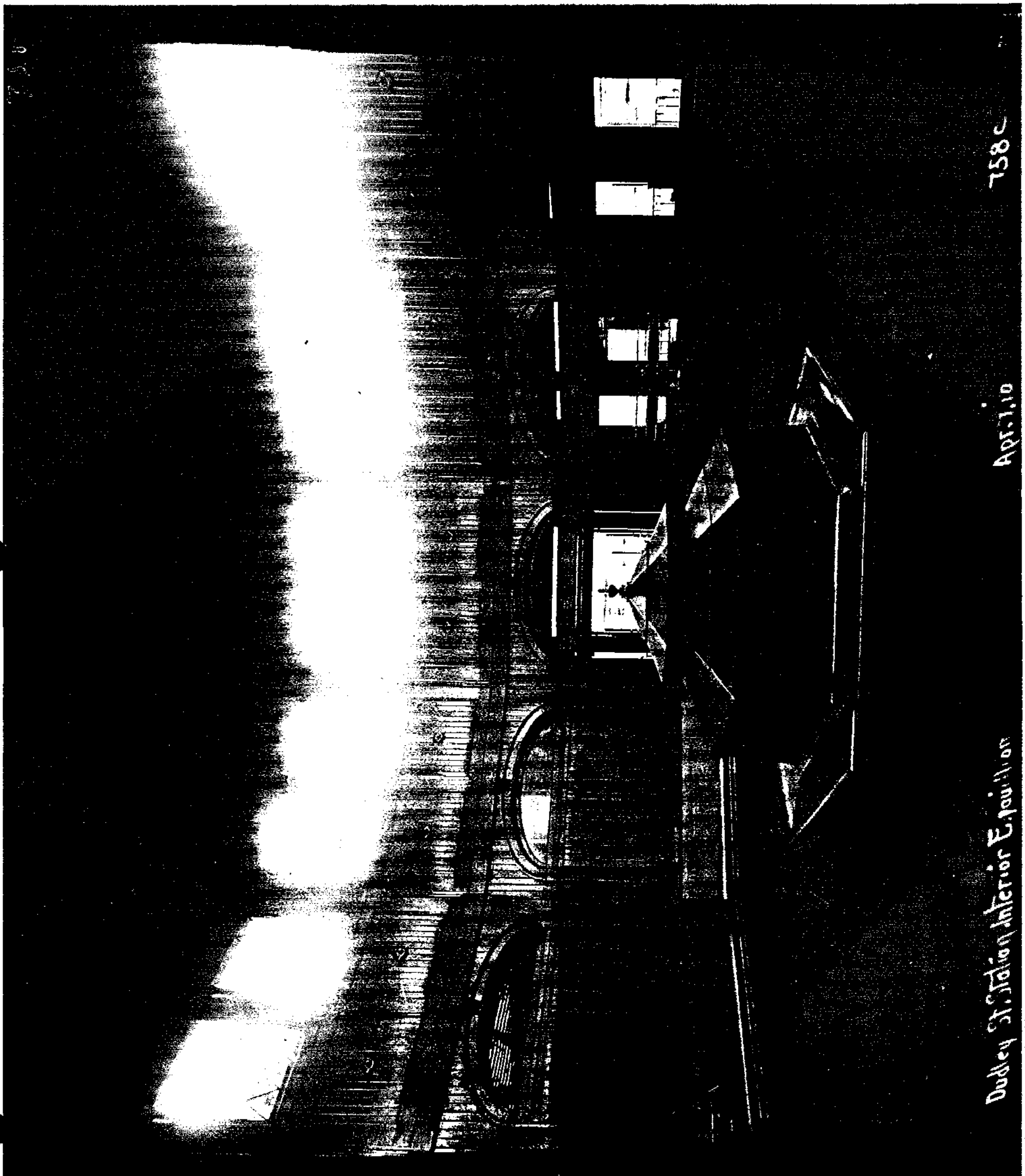
HAER
MASS.
13-BOST,
127-

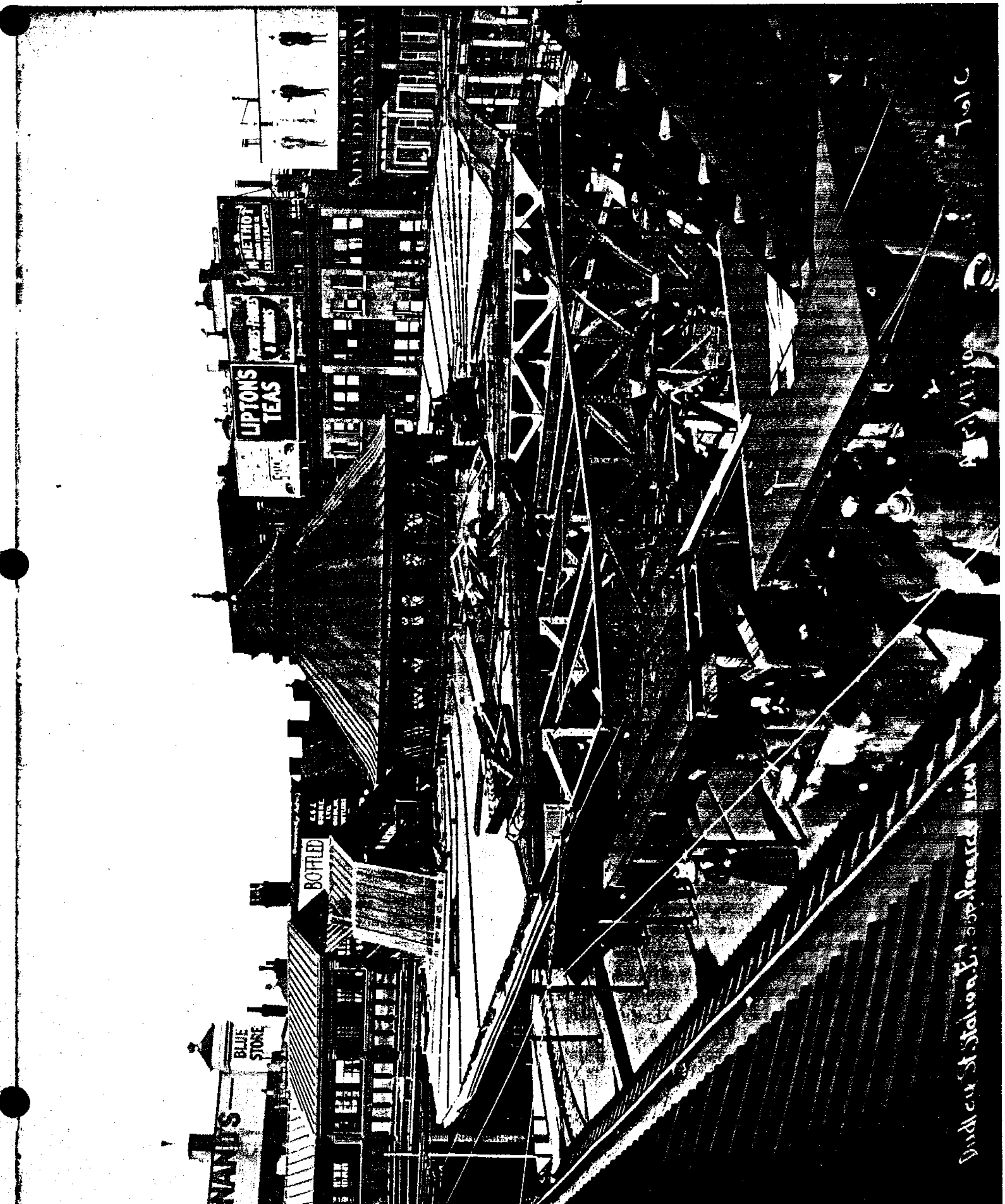


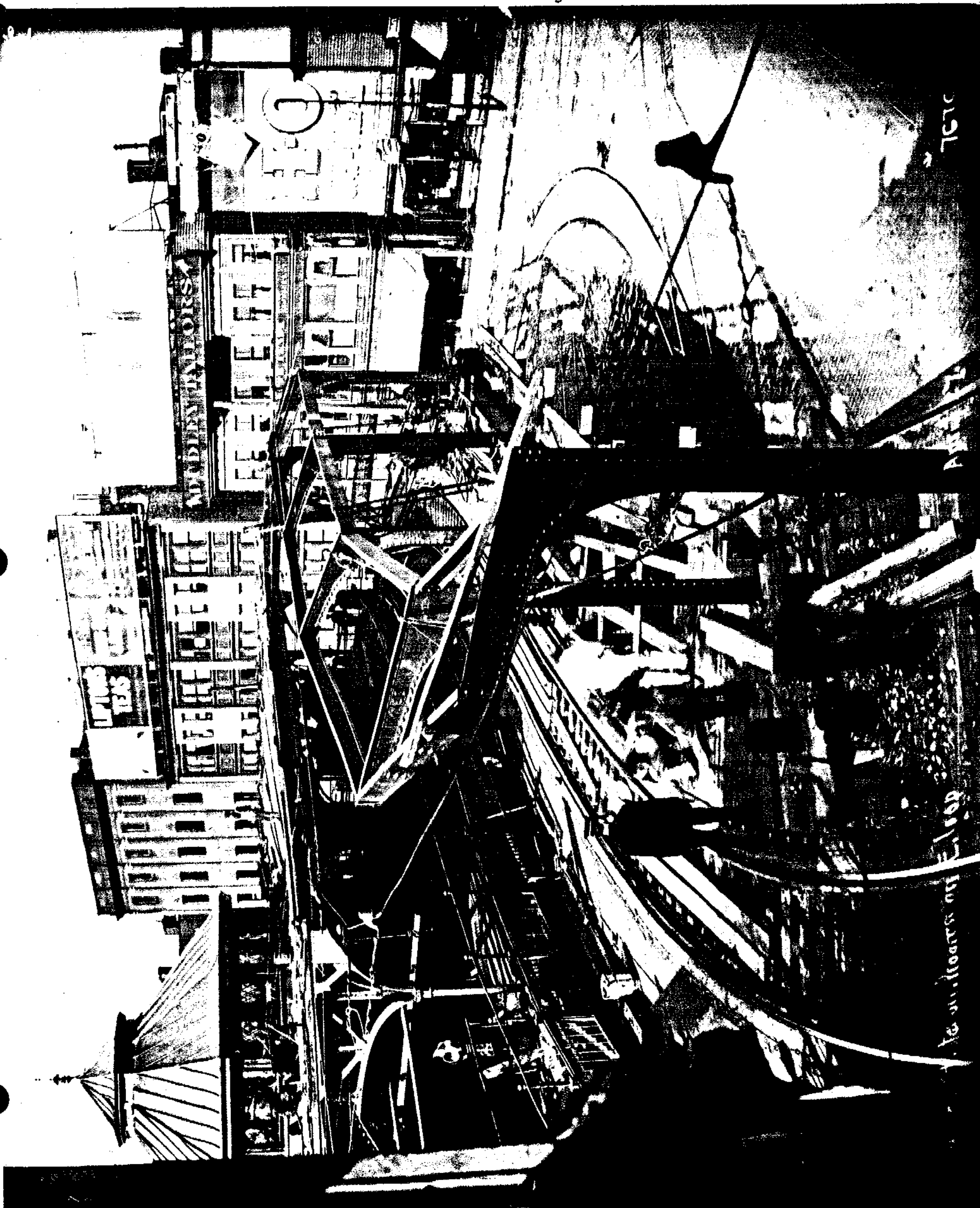


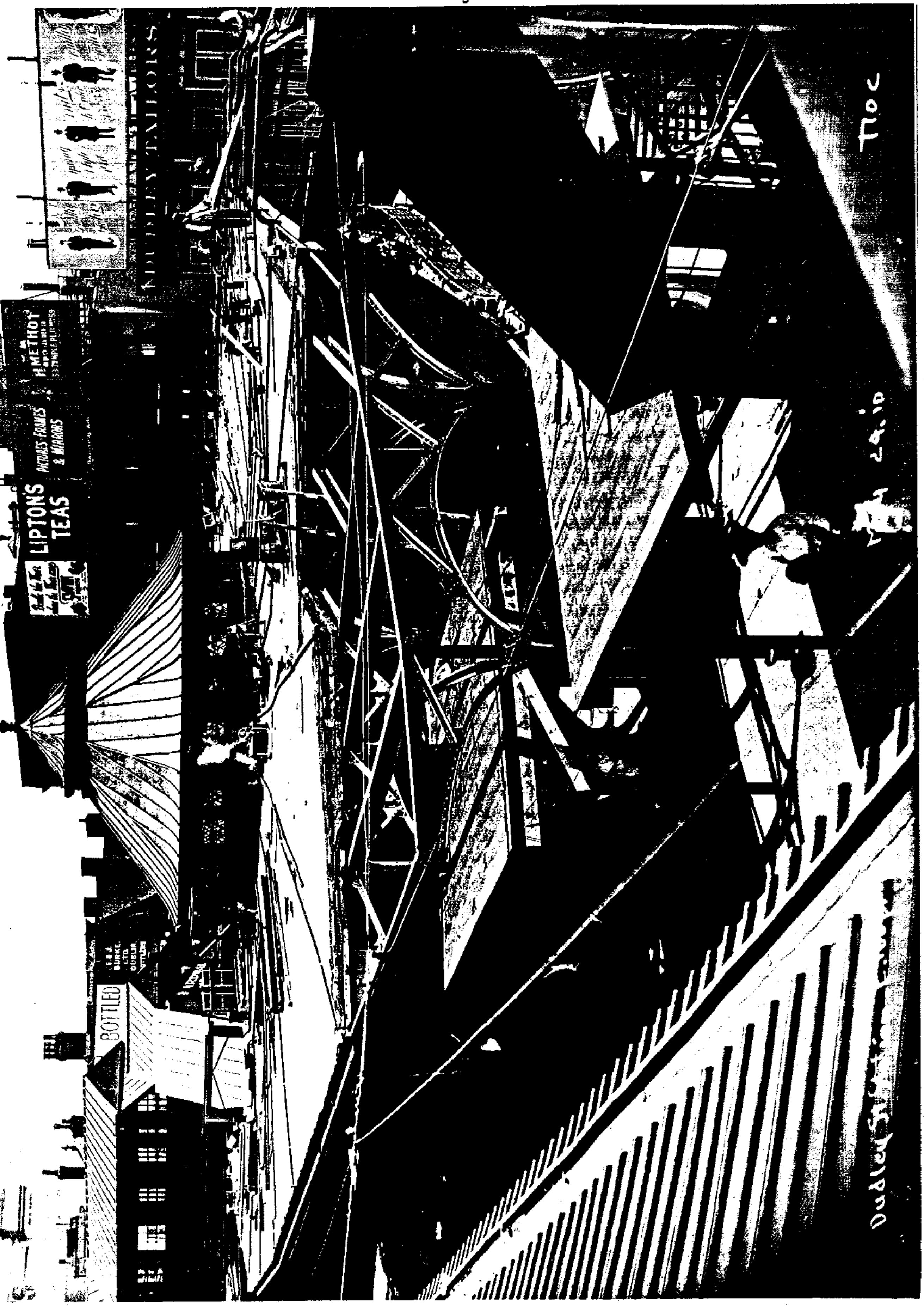

741C
Dec. 16. 09
Dudley St. Station. W. loop.

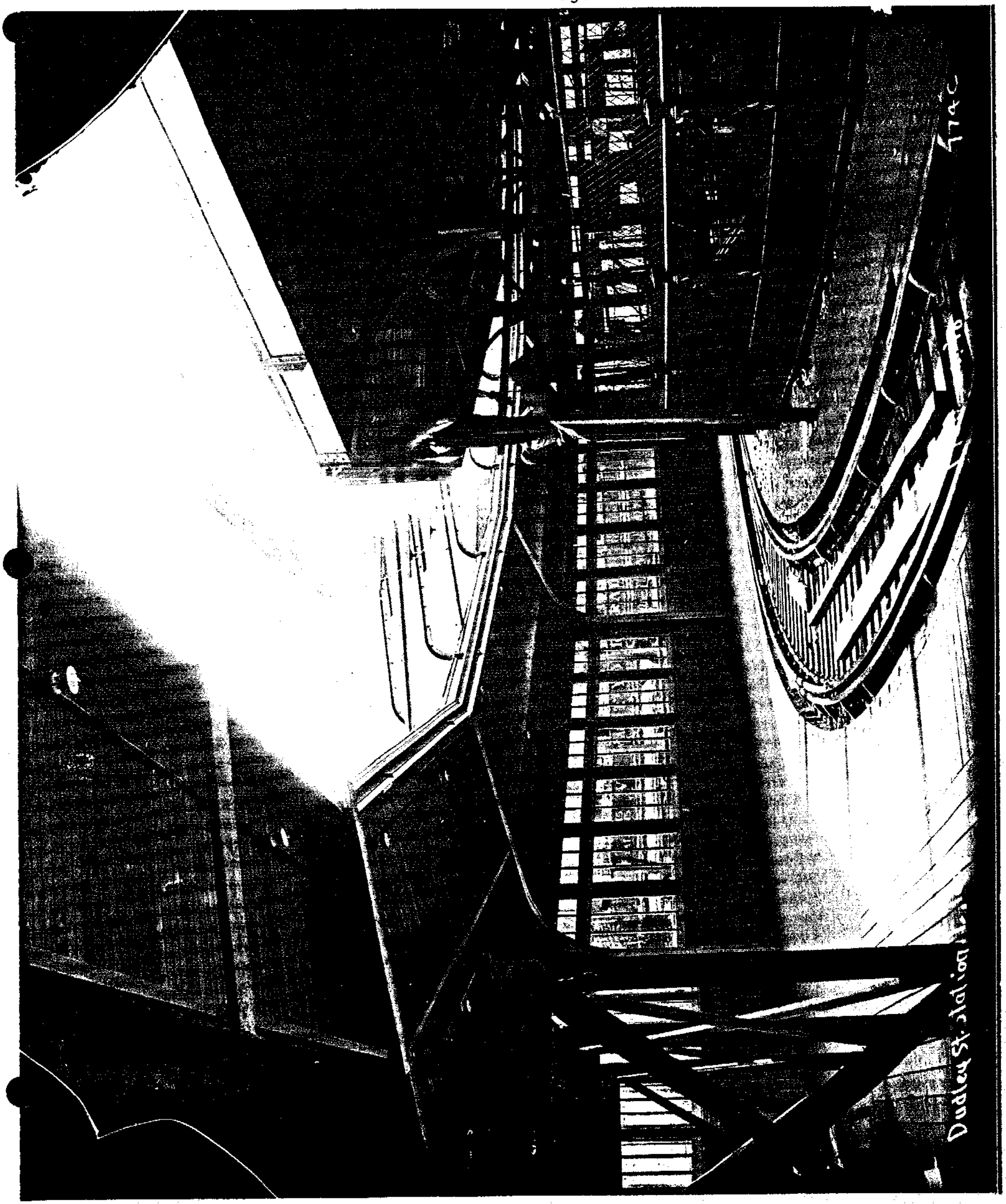

SWAIN & CO.
AND STORAGE WAREHOUSE.
PRIZE WINNERS EAT
GRIST MILL
BREAD
WATERMAN

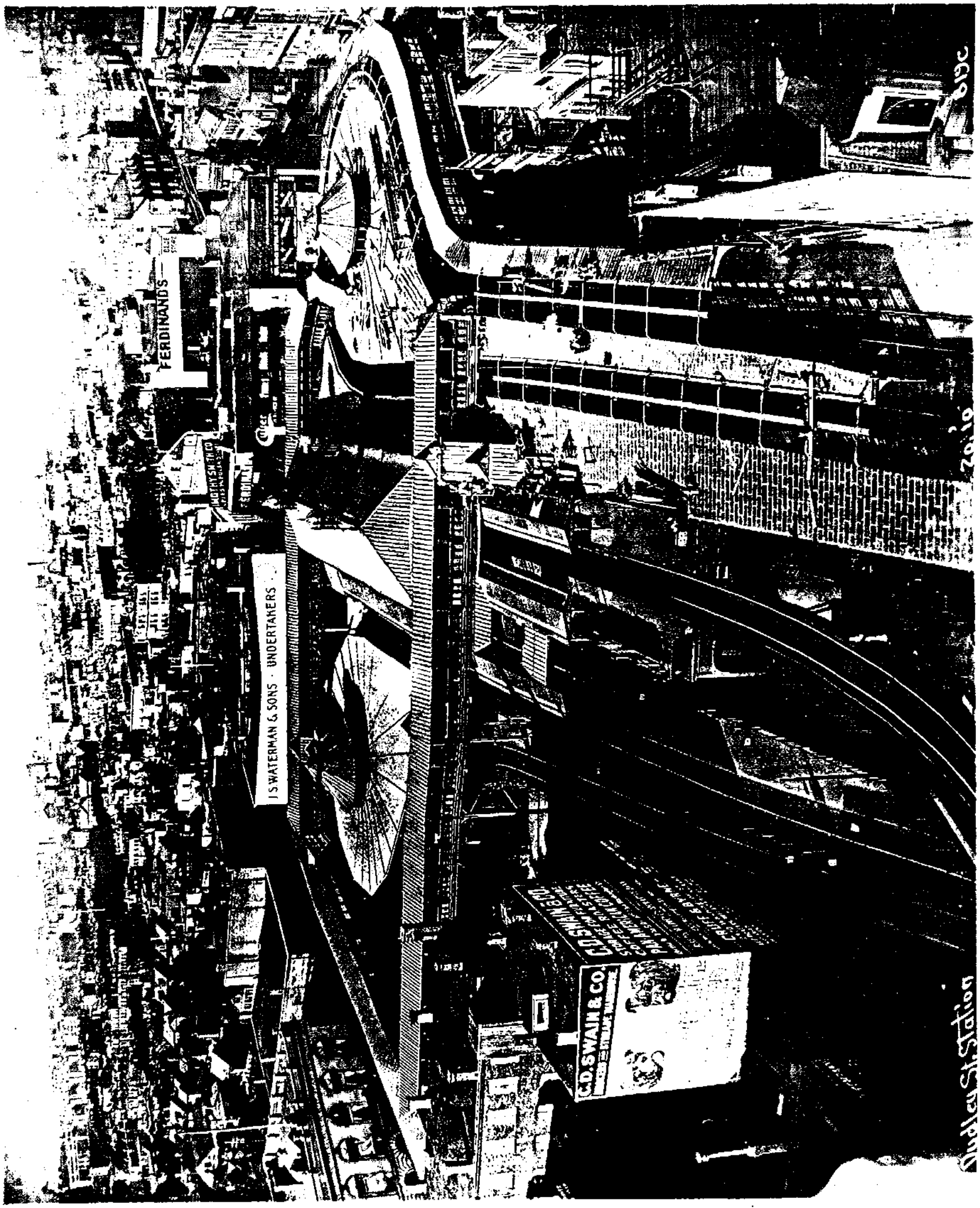

Dudley St. Station Interior E. pavilion
Apr. 1, 10
758C

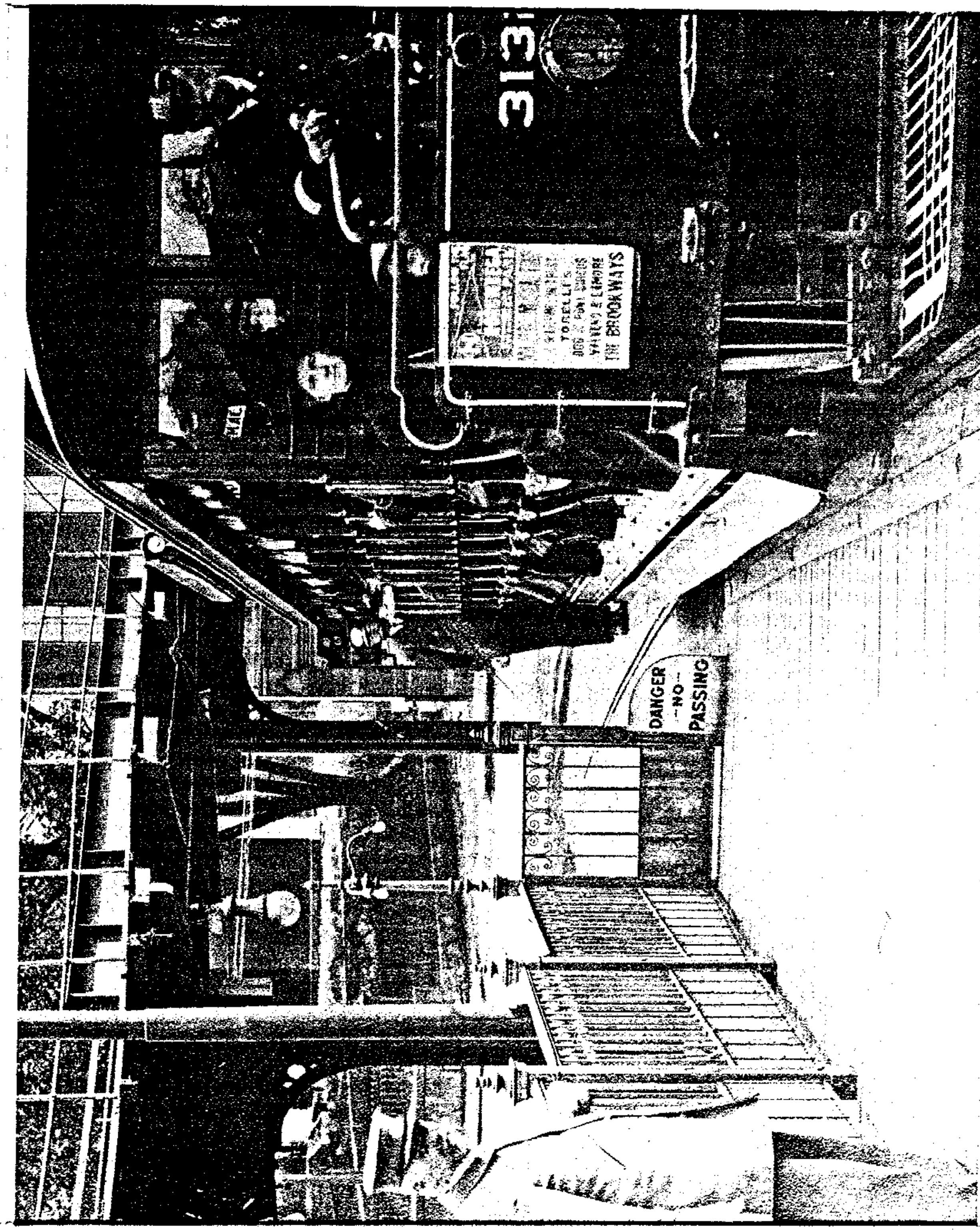

LIPTONS TEAS
BOTTLED
BLUE STORE

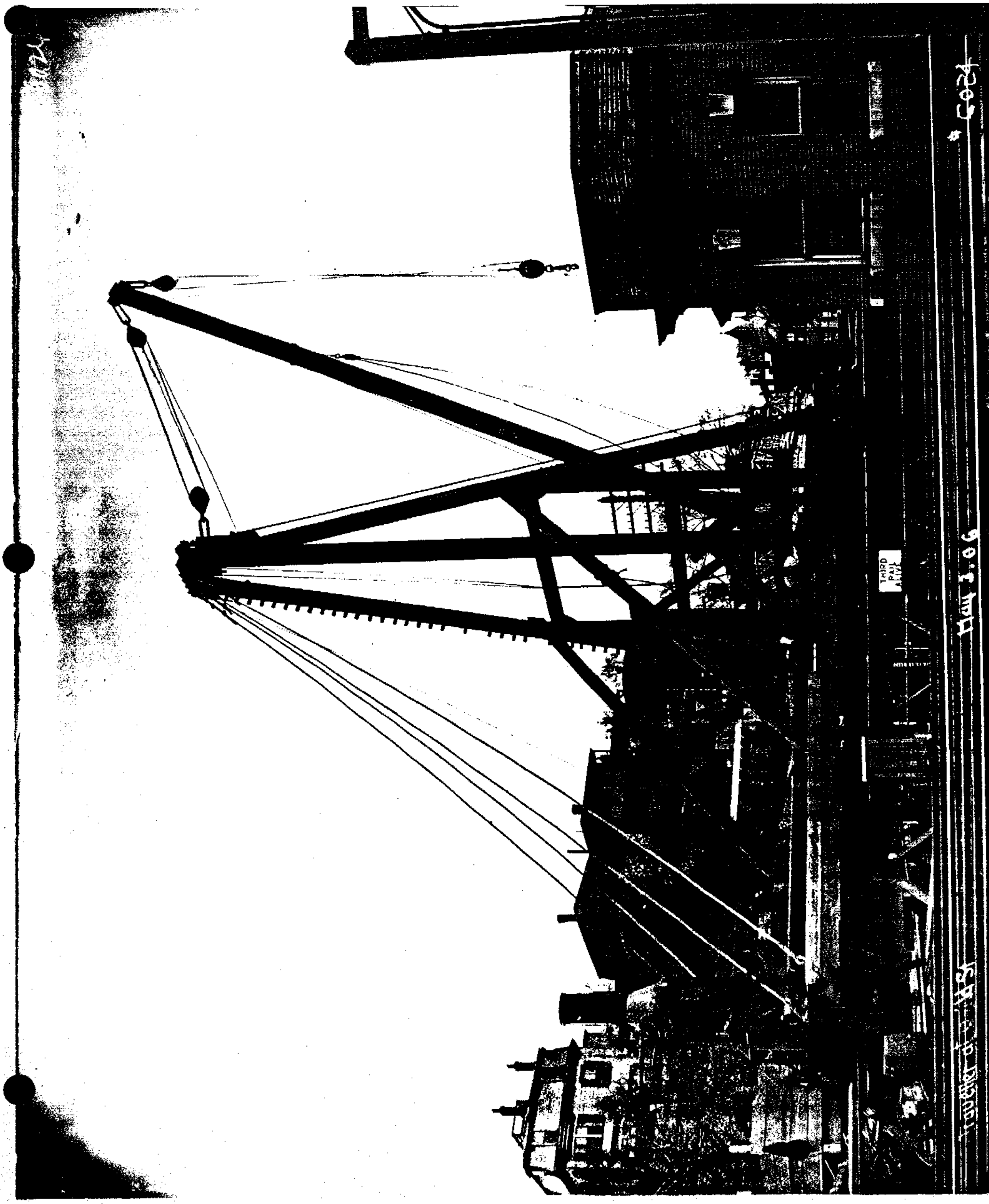


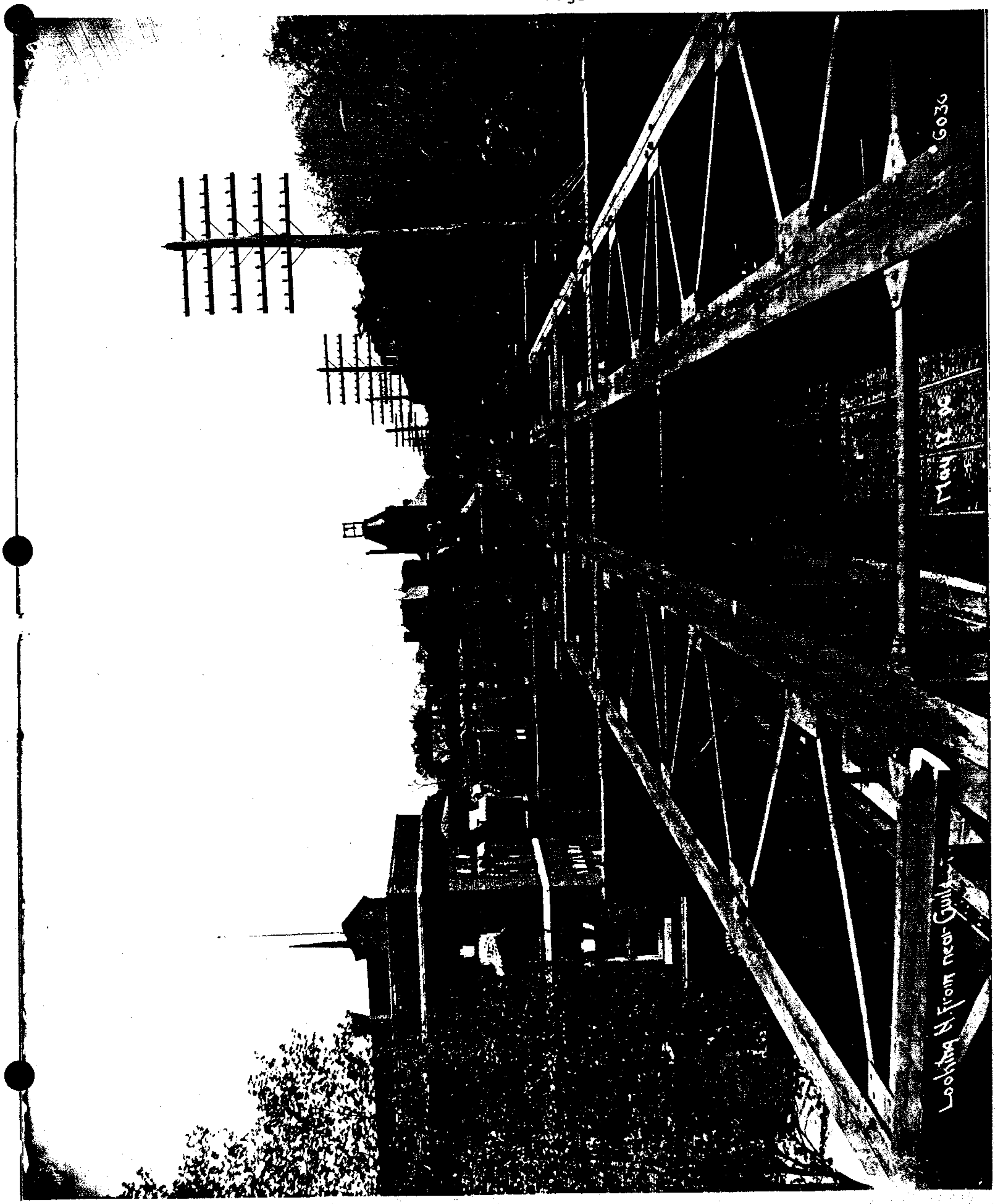

LIPTON'S
TEAS
PICTURES-FRAMES
& MIRRORS
BOTTLED

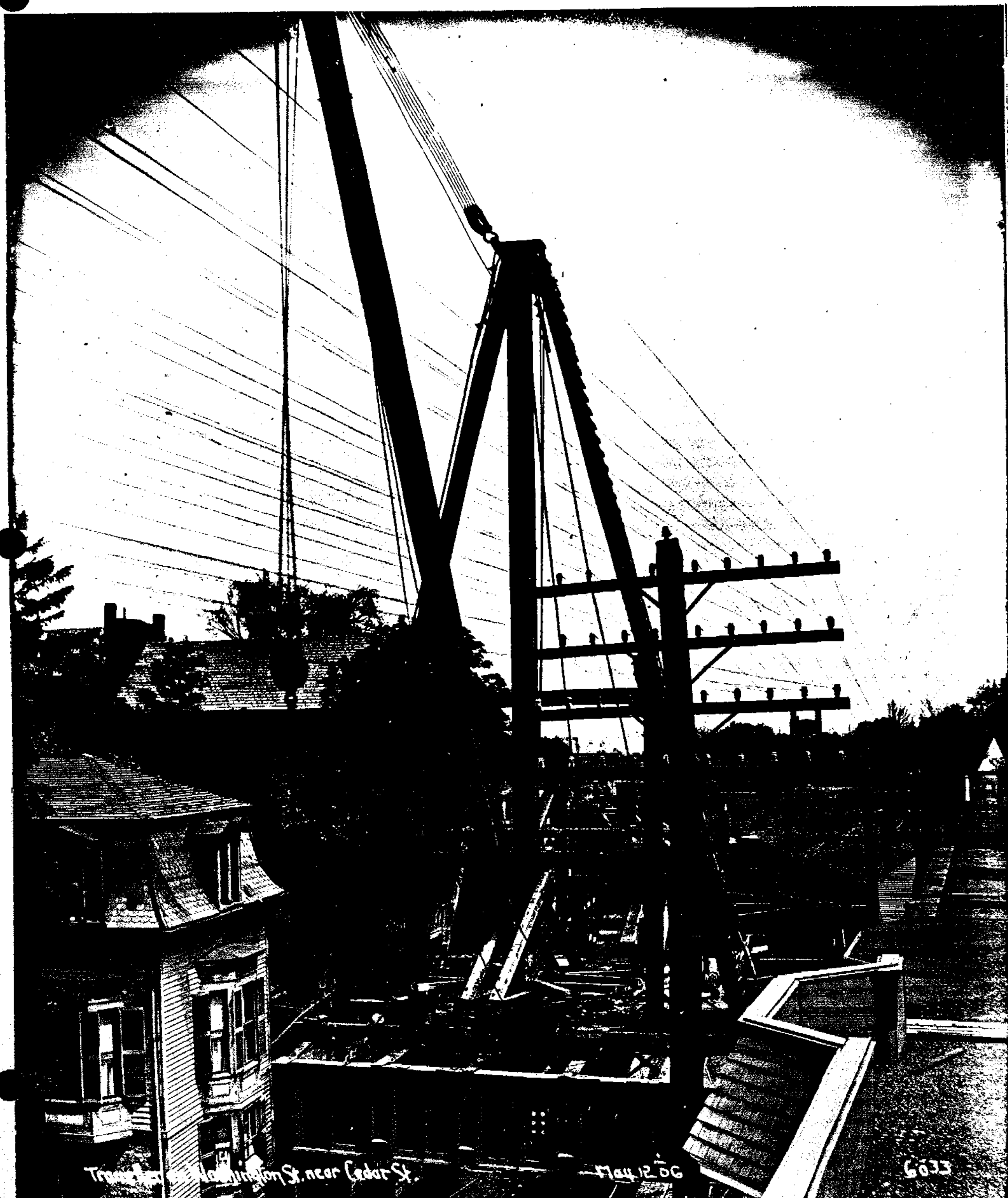

Dudley St. station

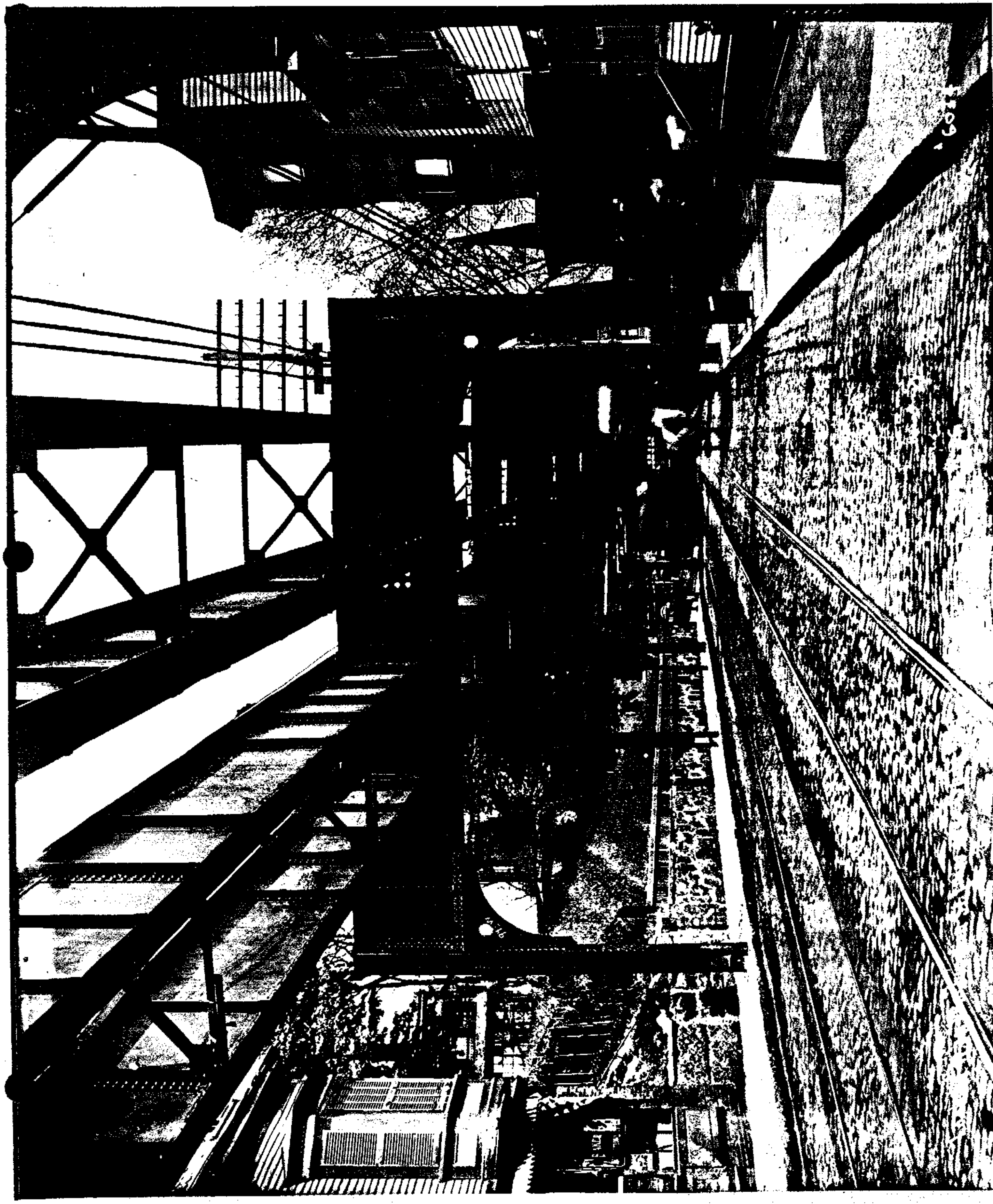

FERDINANDS
J.S. WATERMAN & SONS · UNDERTAKERS
C.D. SWAIN & CO.
Dudley St. Station

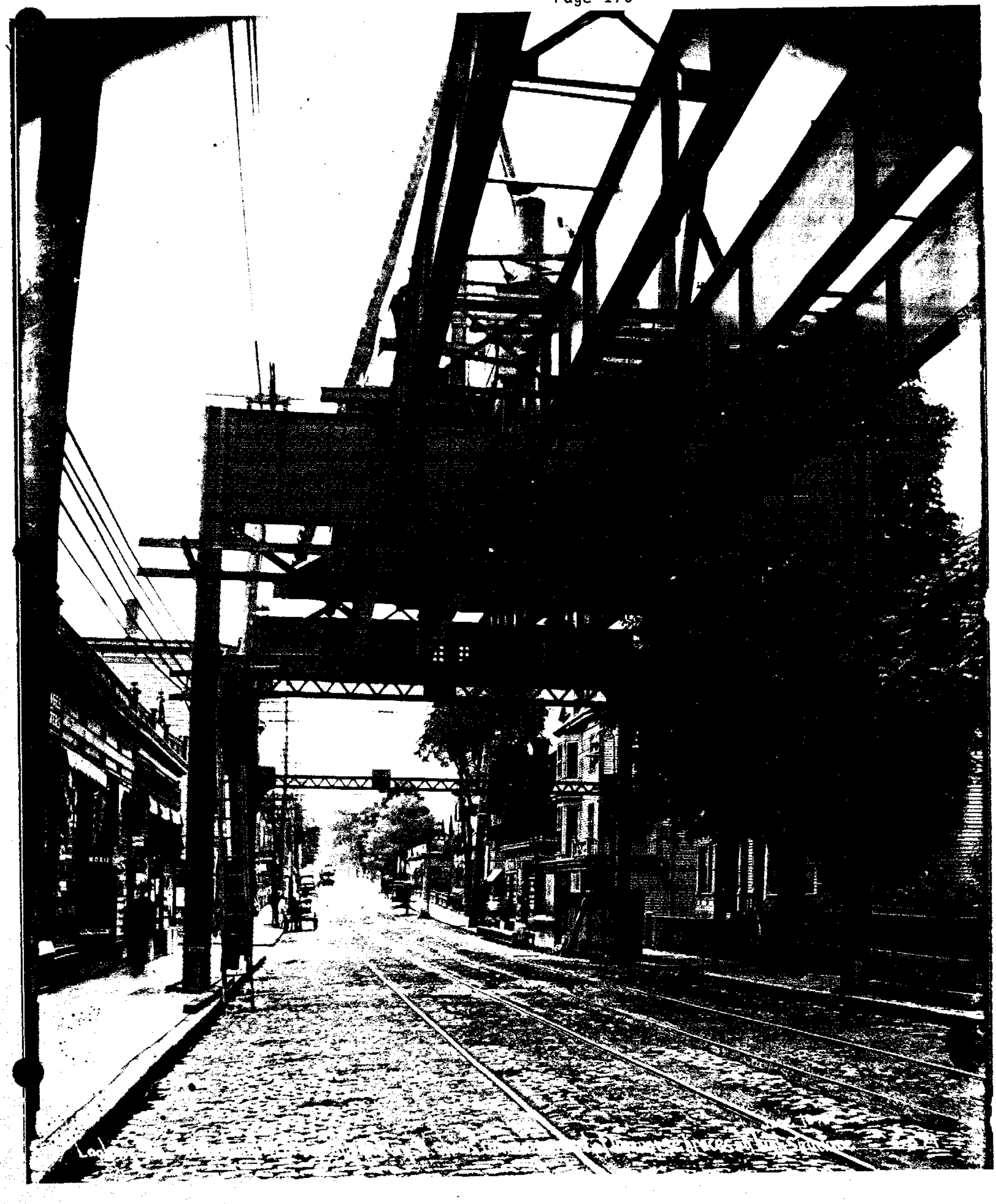

313
THE BROOKWAYS
DANGER
-NO-
PASSING

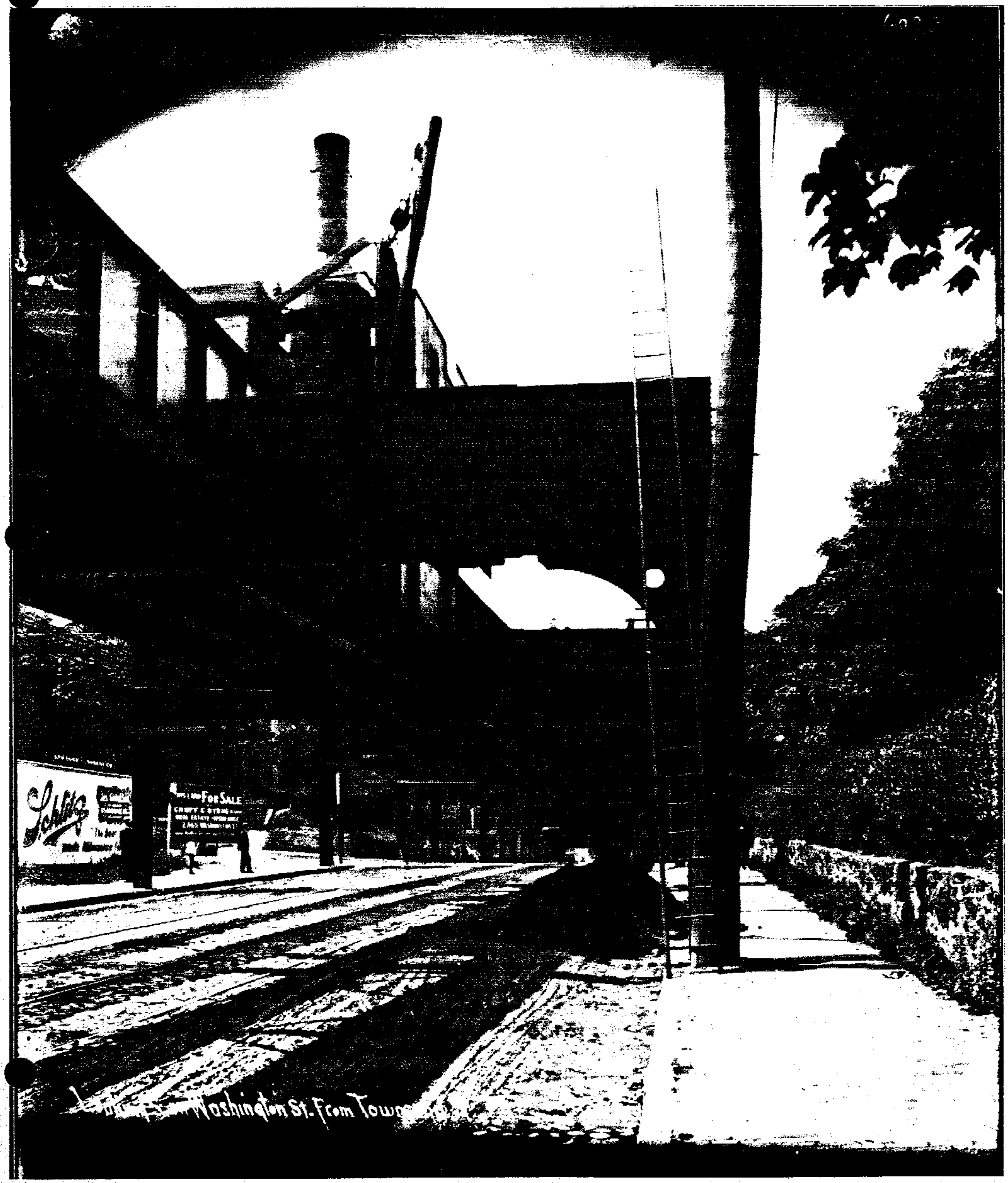


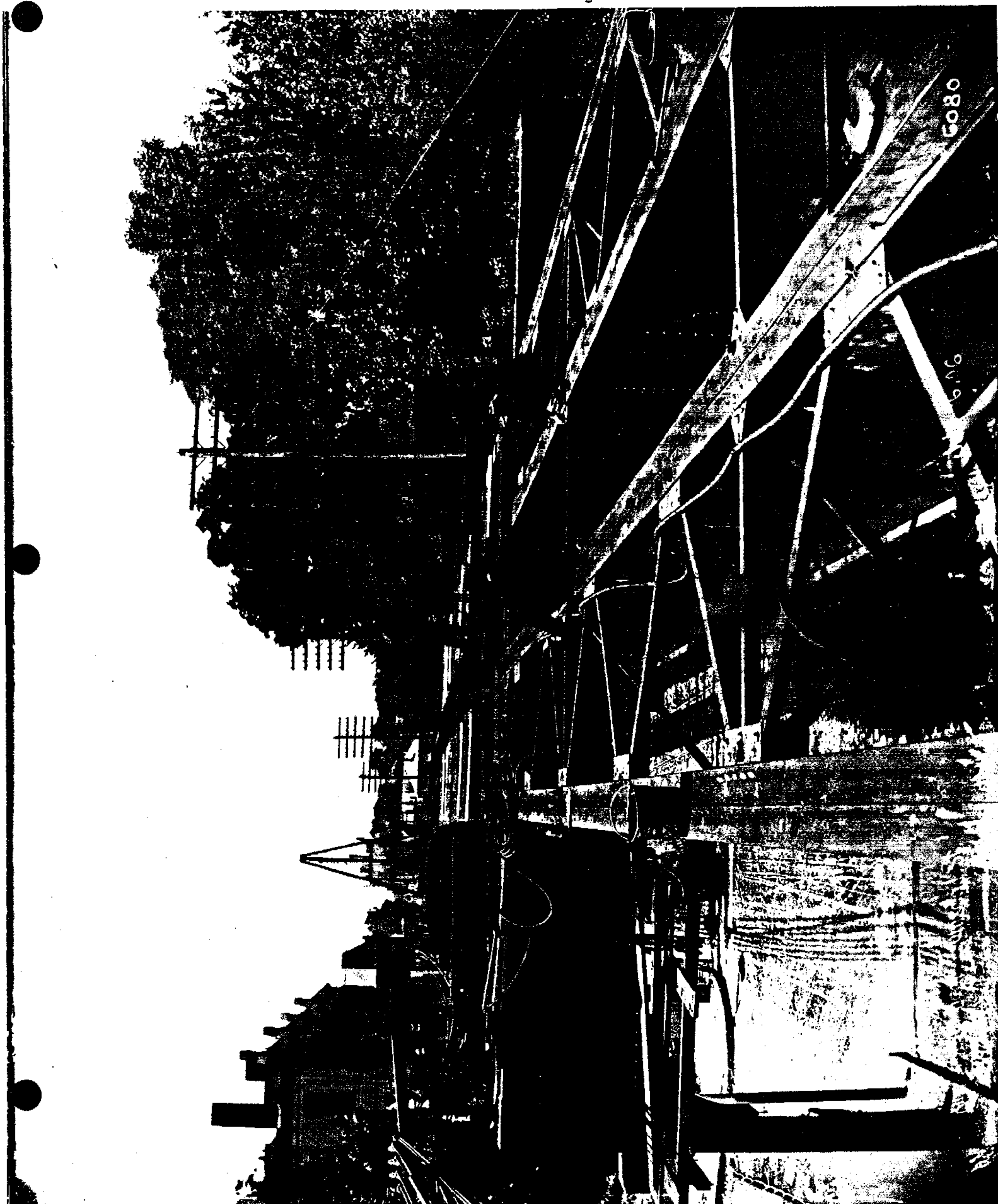

G036
Looking N. from near Guild


Washington St. near Cedar St.
May 12 06
6033

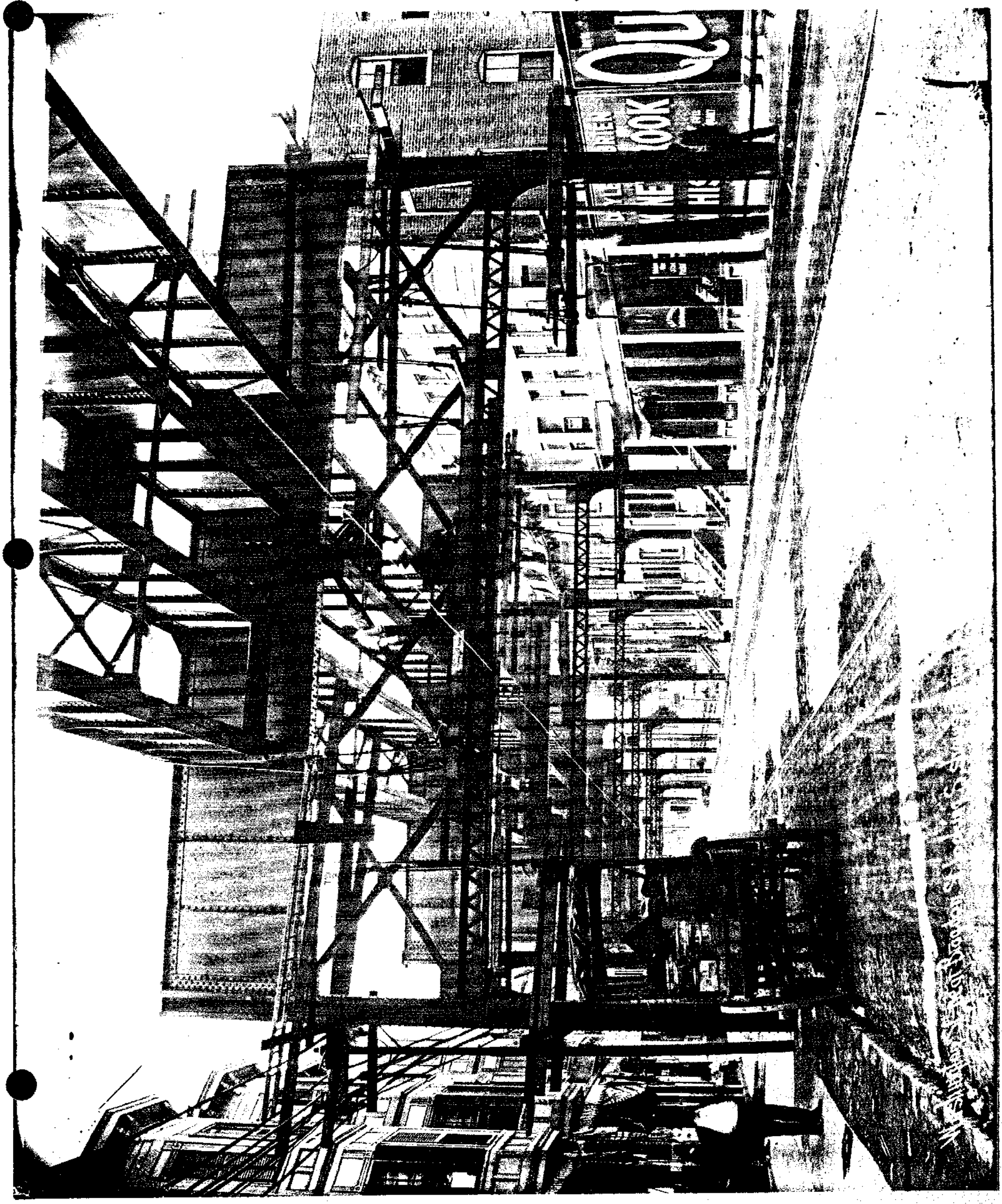




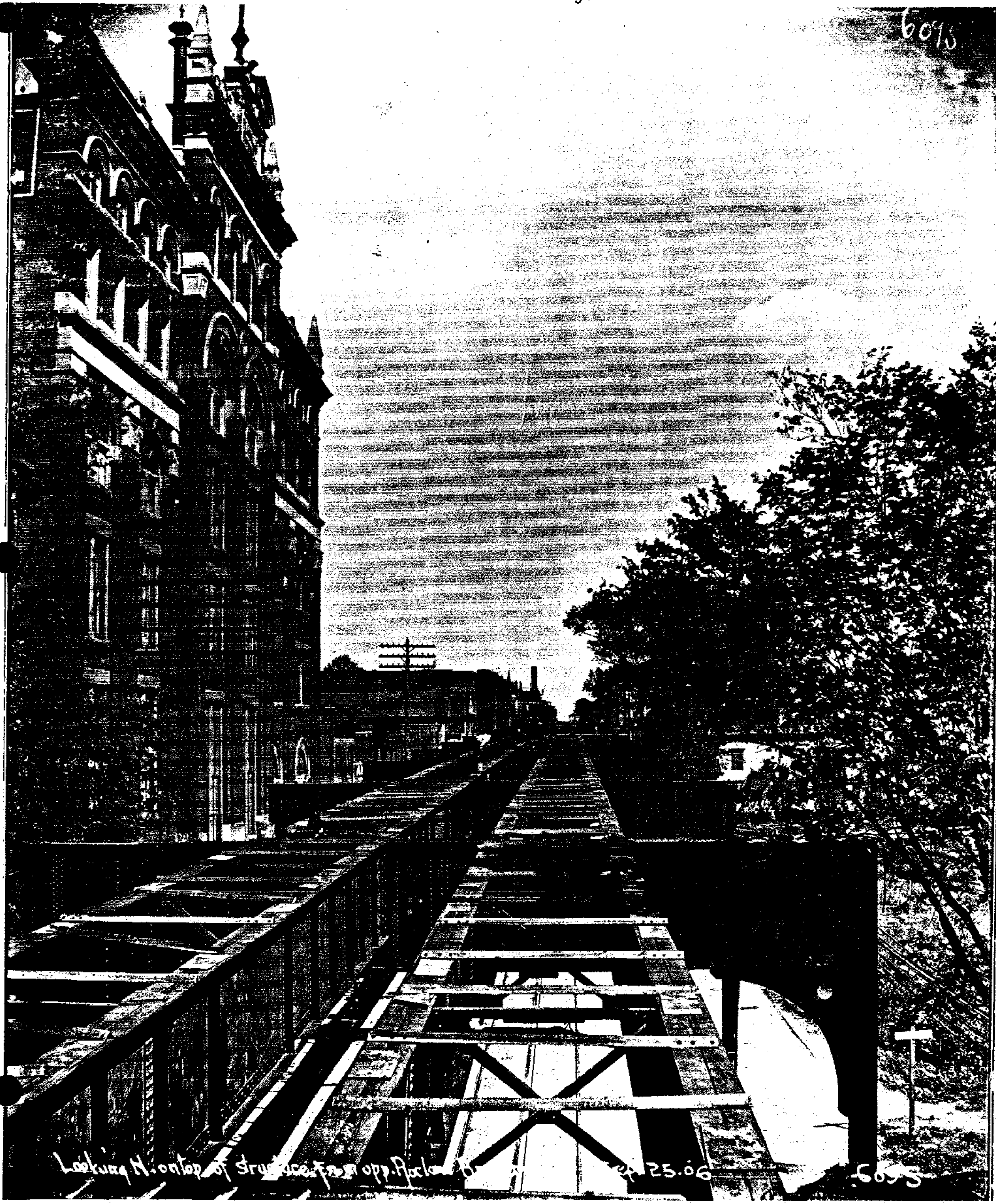

Schlitz
FOR SALE
Washington St. From Town

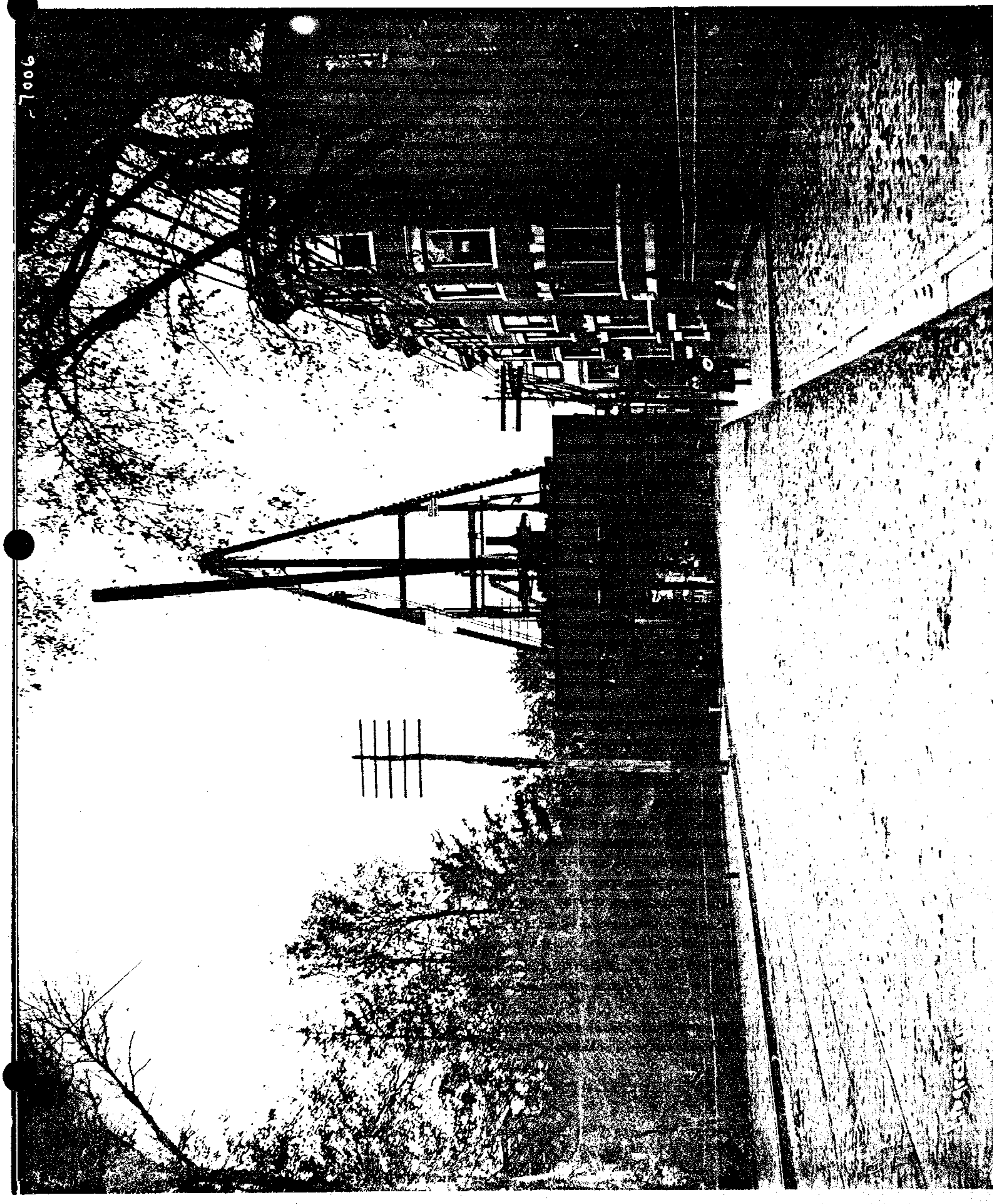

6080

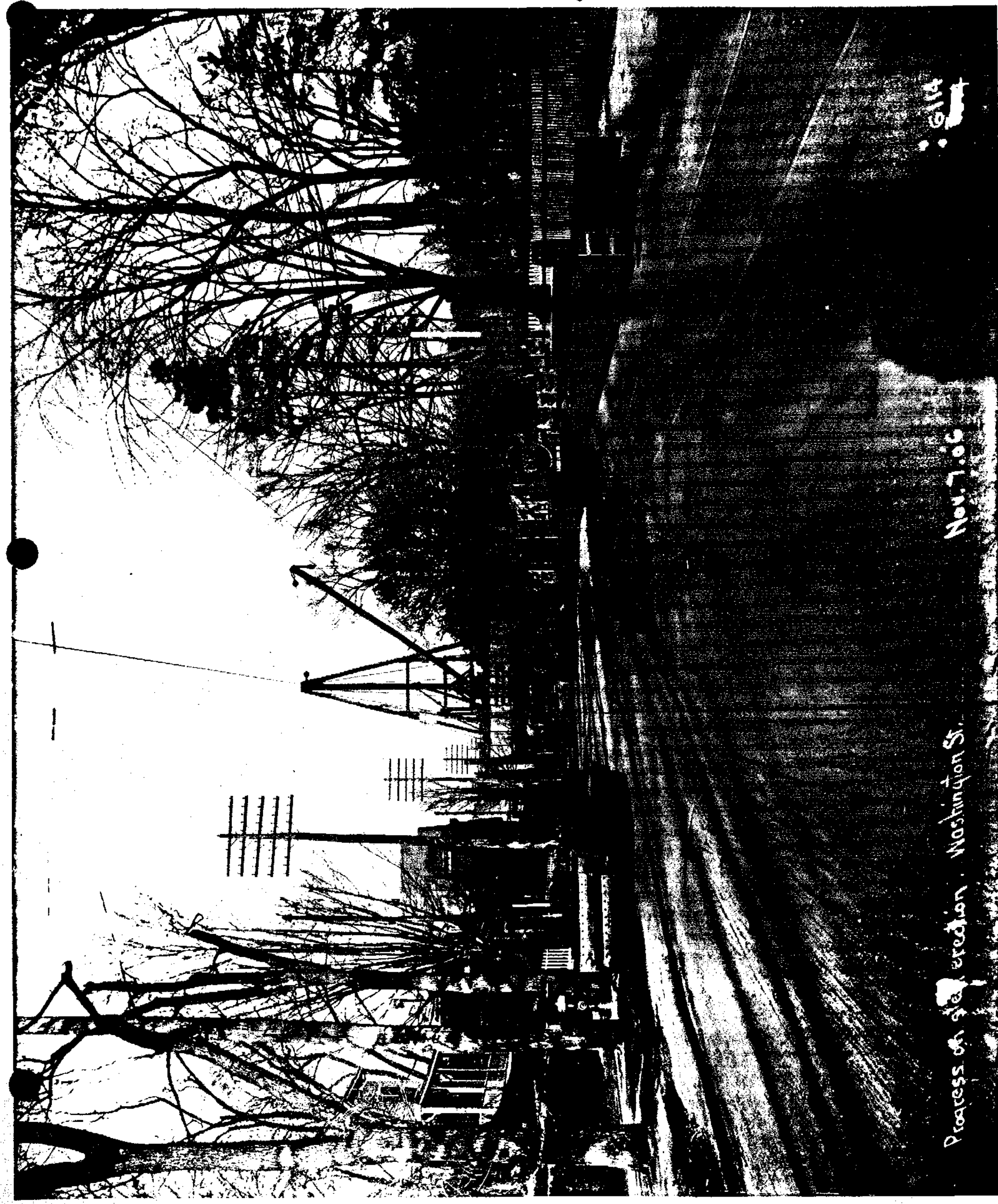

FORT PITT
BRIDGE WORKS
Washington St. at Bray St.
Aug 13.06
C081

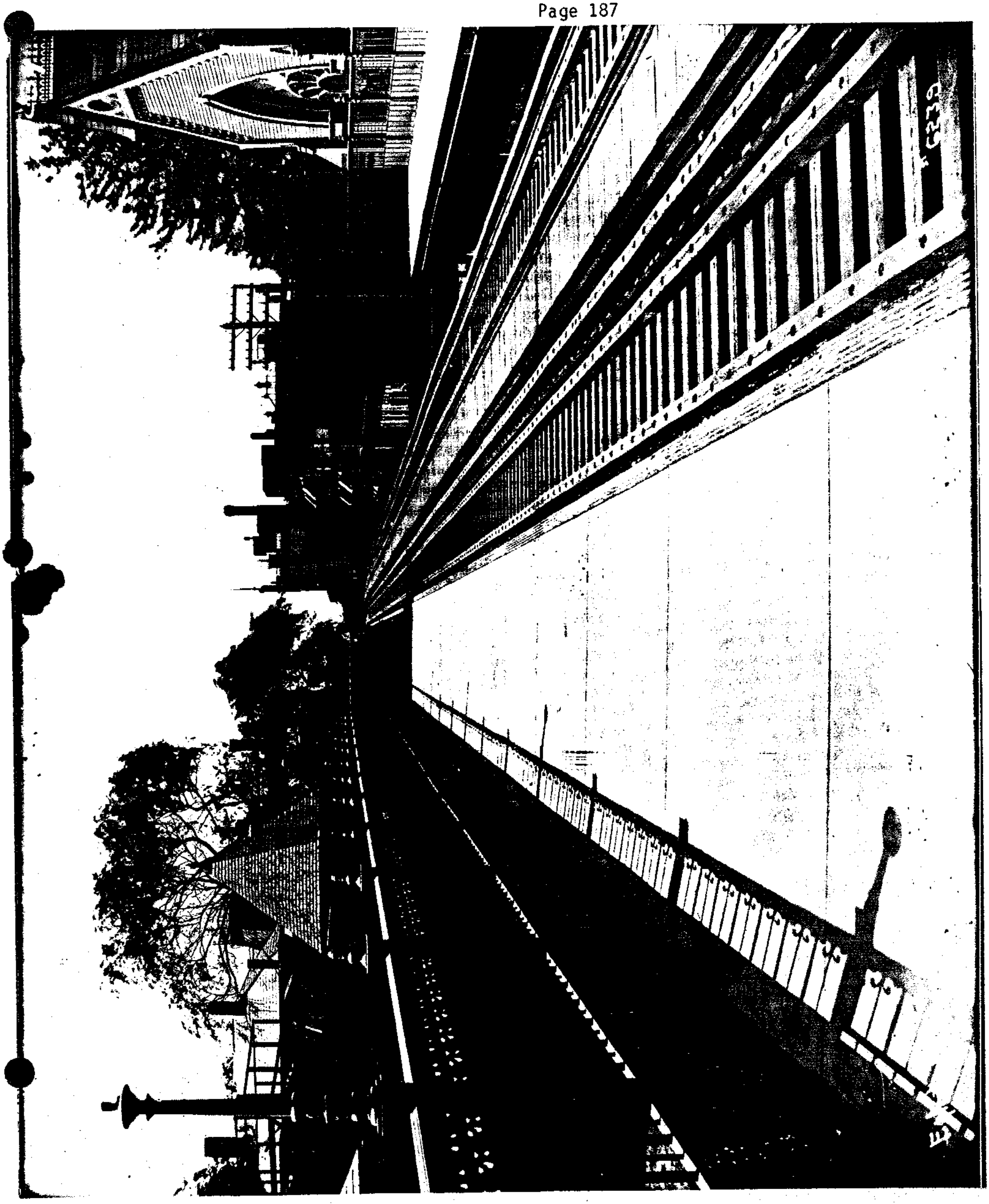


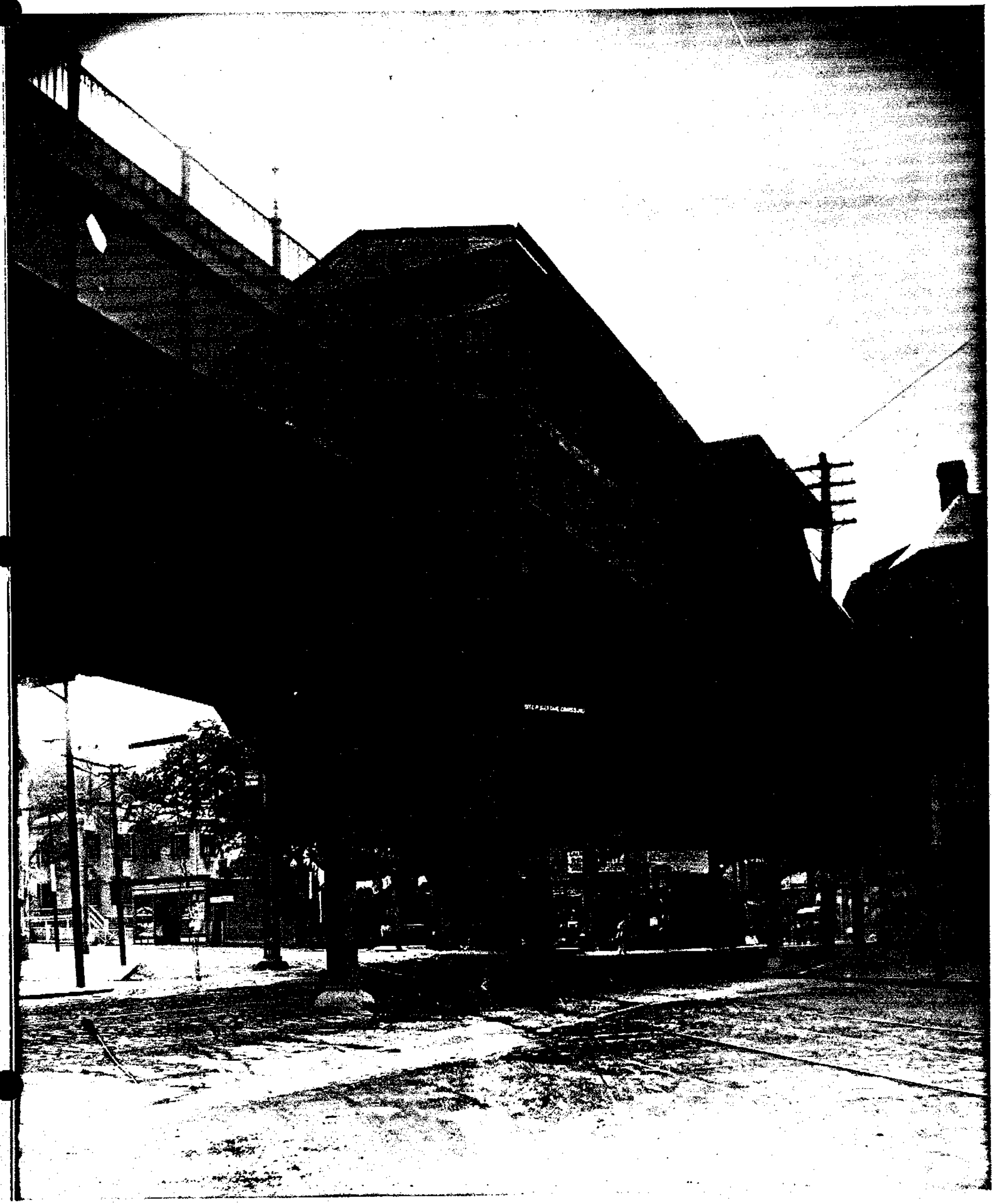

BISCUIT COMPANY

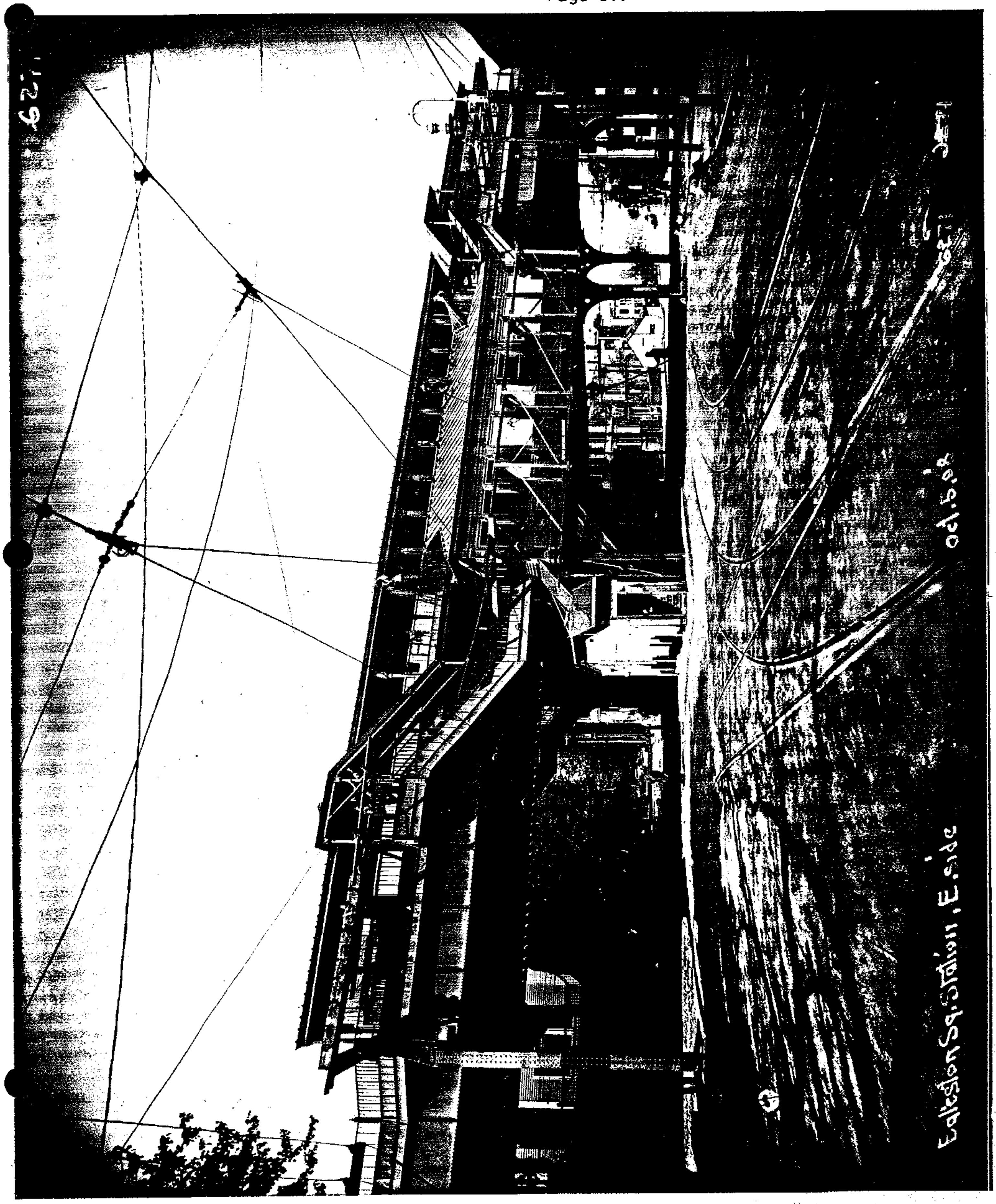

Looking N. on top of structure from opp.
25.06
6095

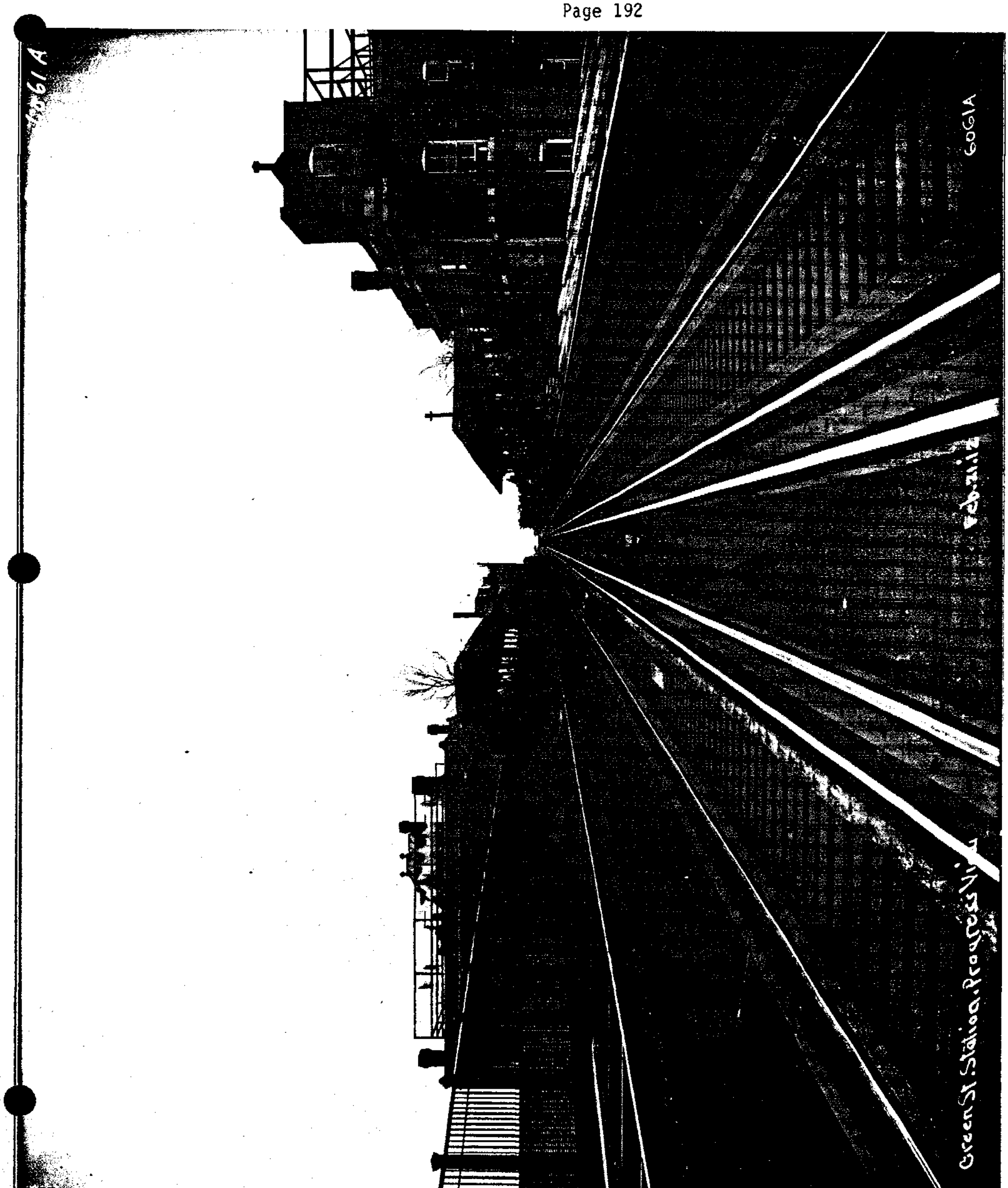


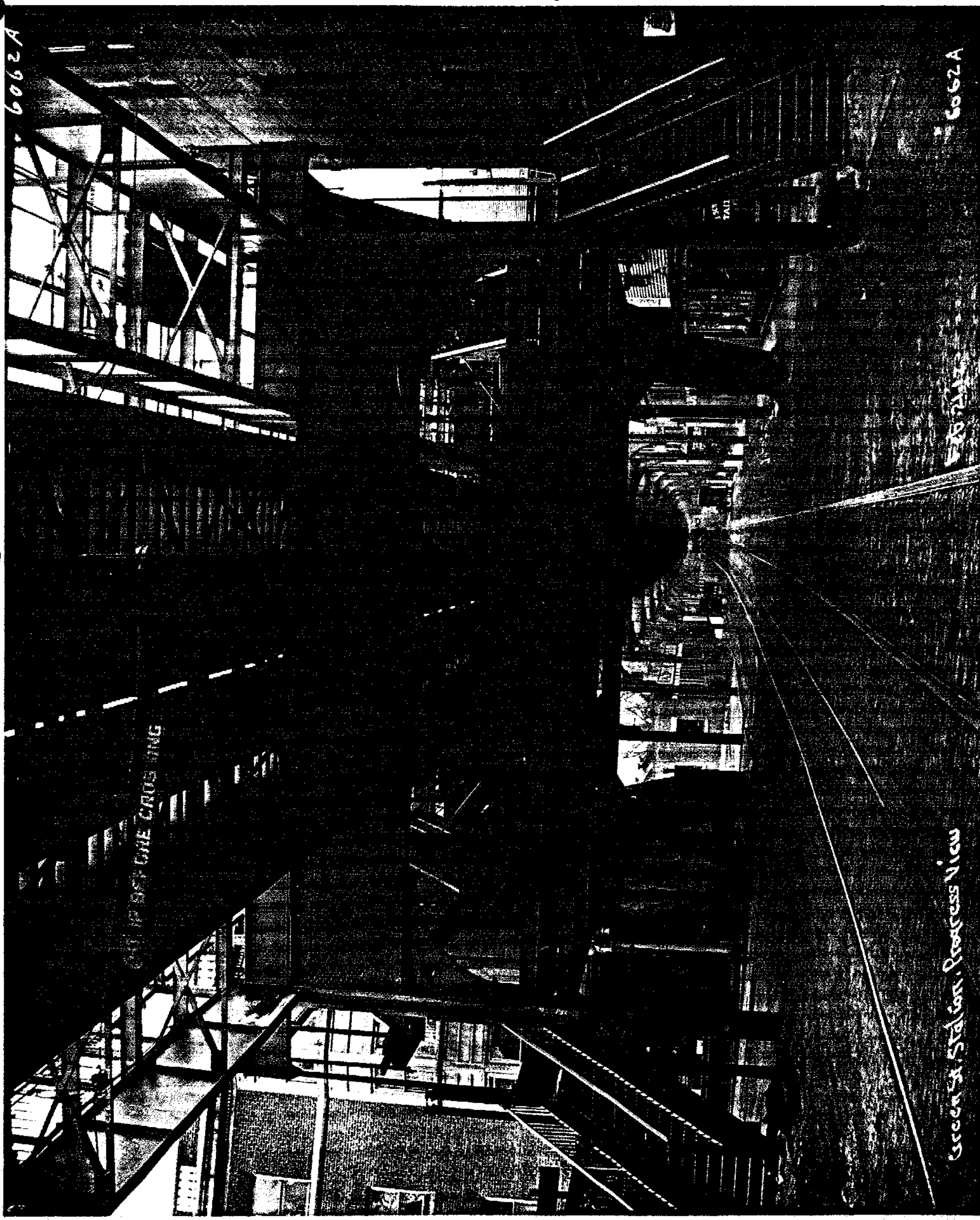

6114
Process on ele erection. Washington St. Nov. 7.06



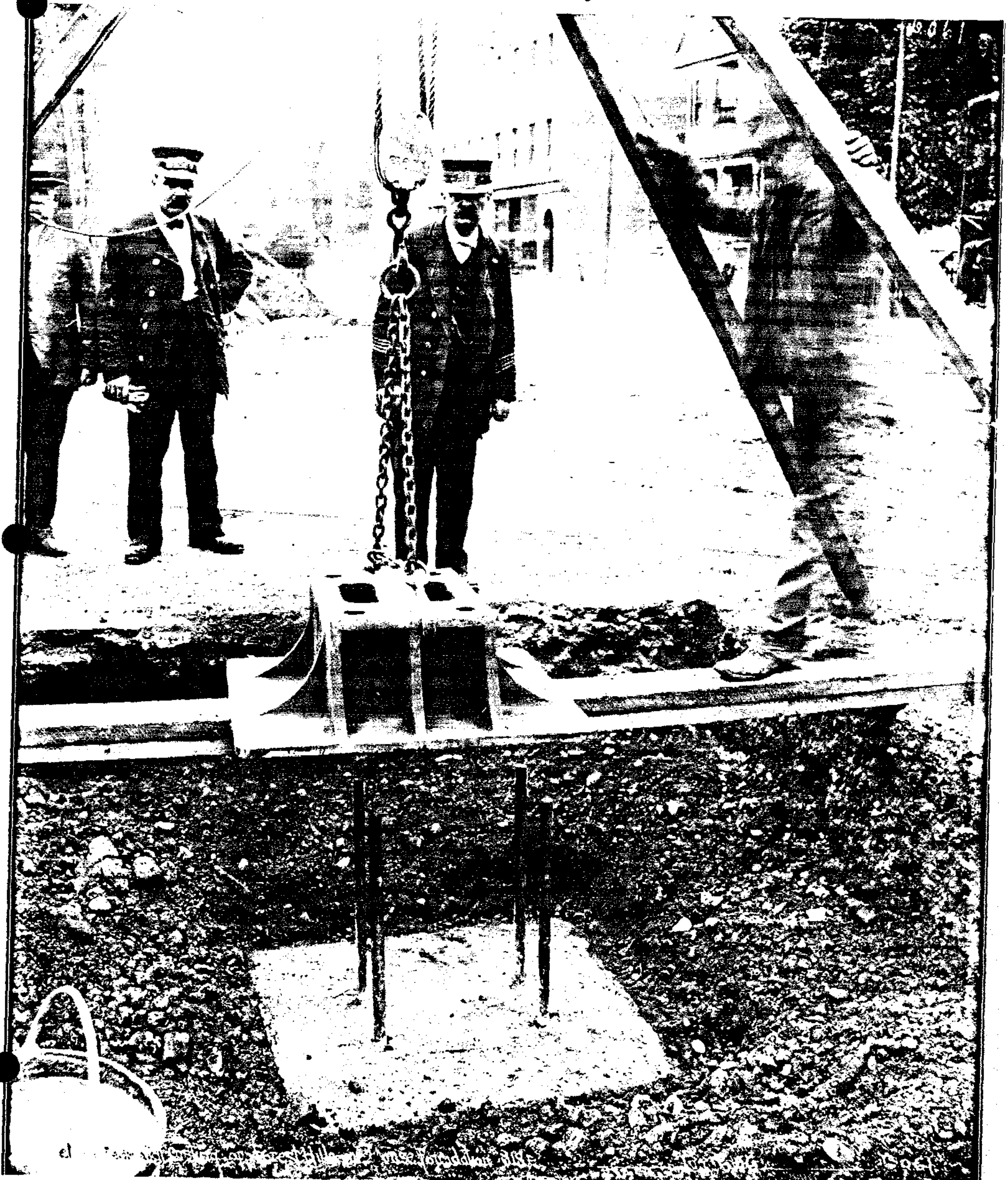



Egleston Sq. Station, E. side
Oct. 5. 08

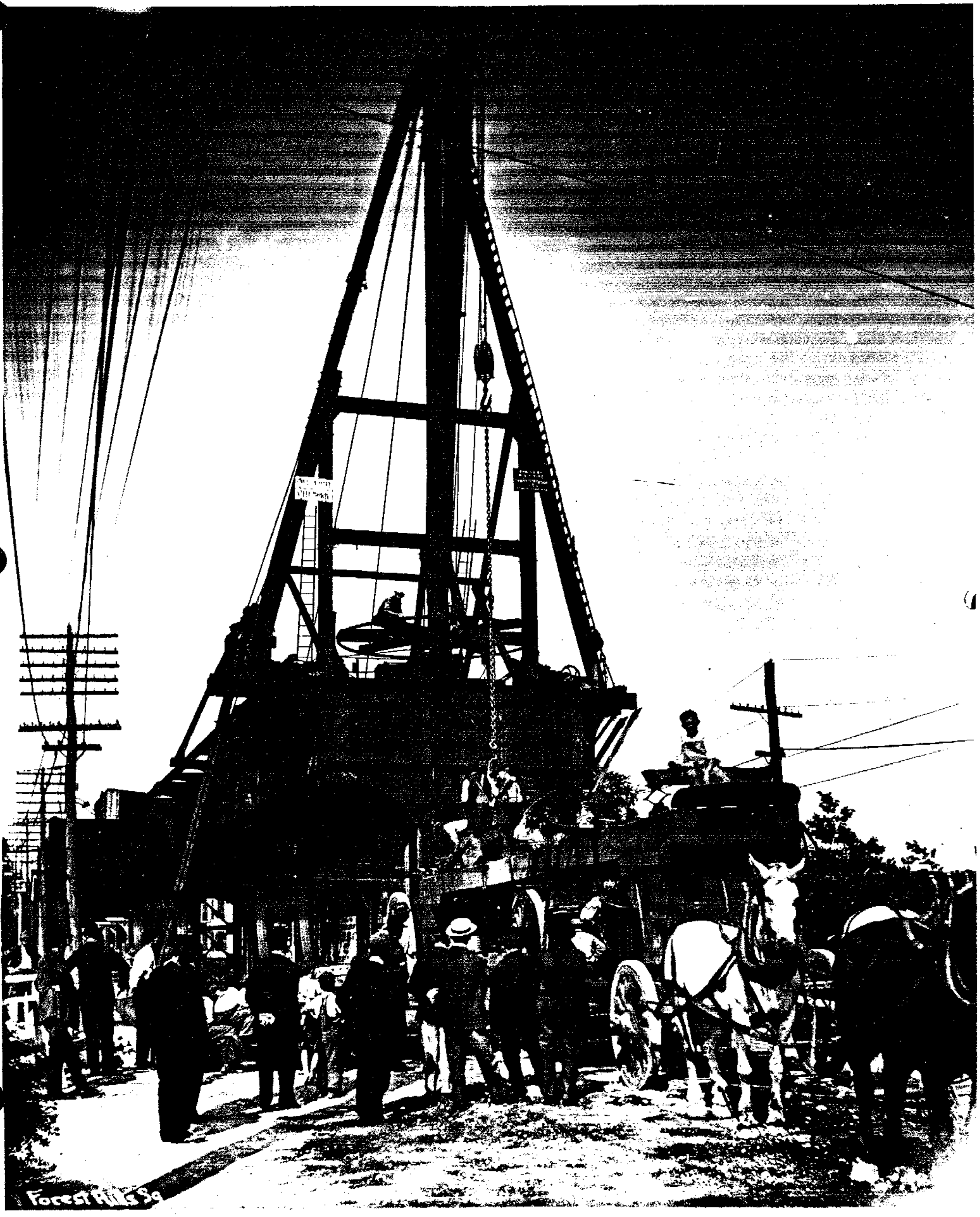

6061A
Green St. Station. Progress View

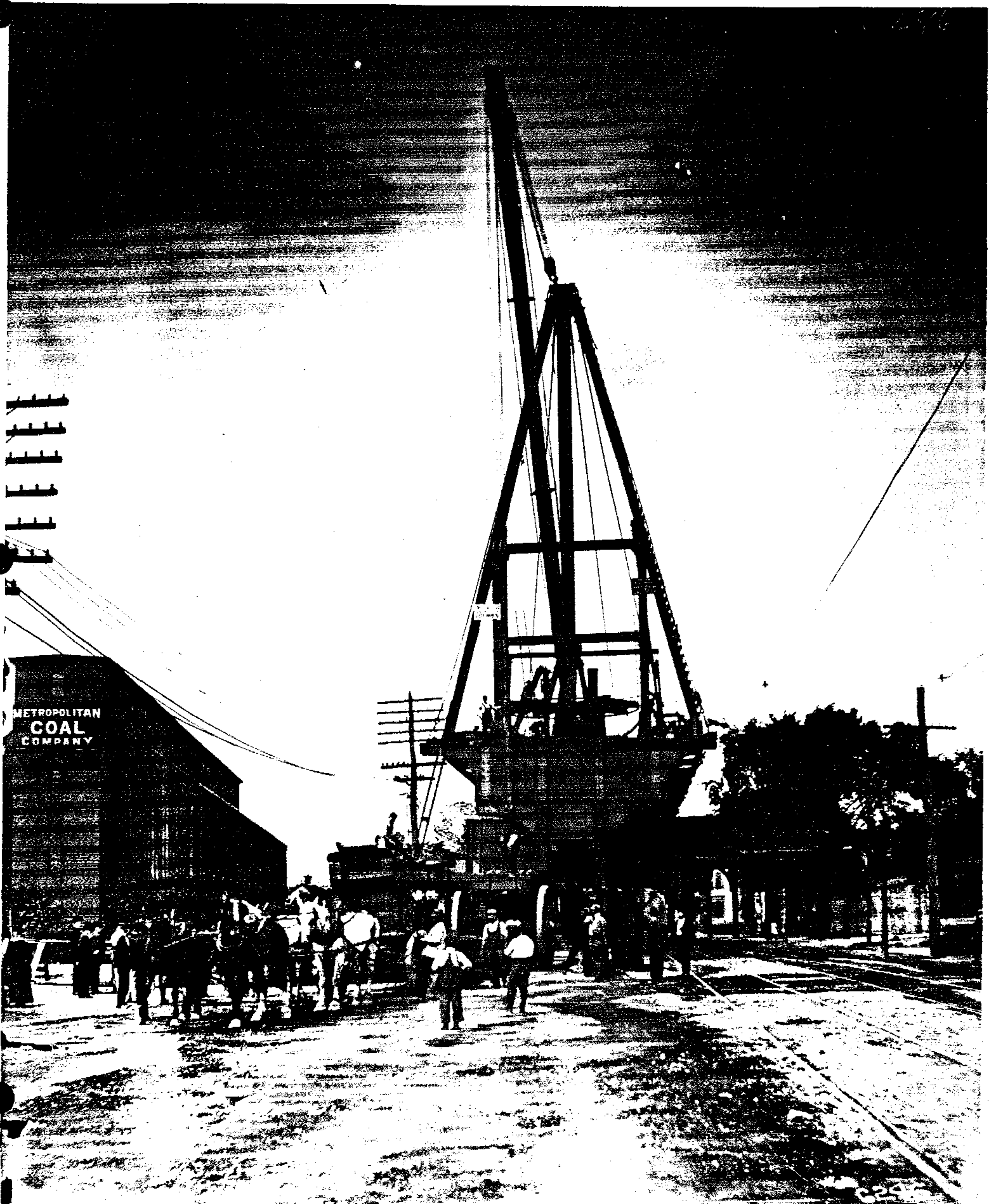

6062A
Green St. Station, Progress View
6062A

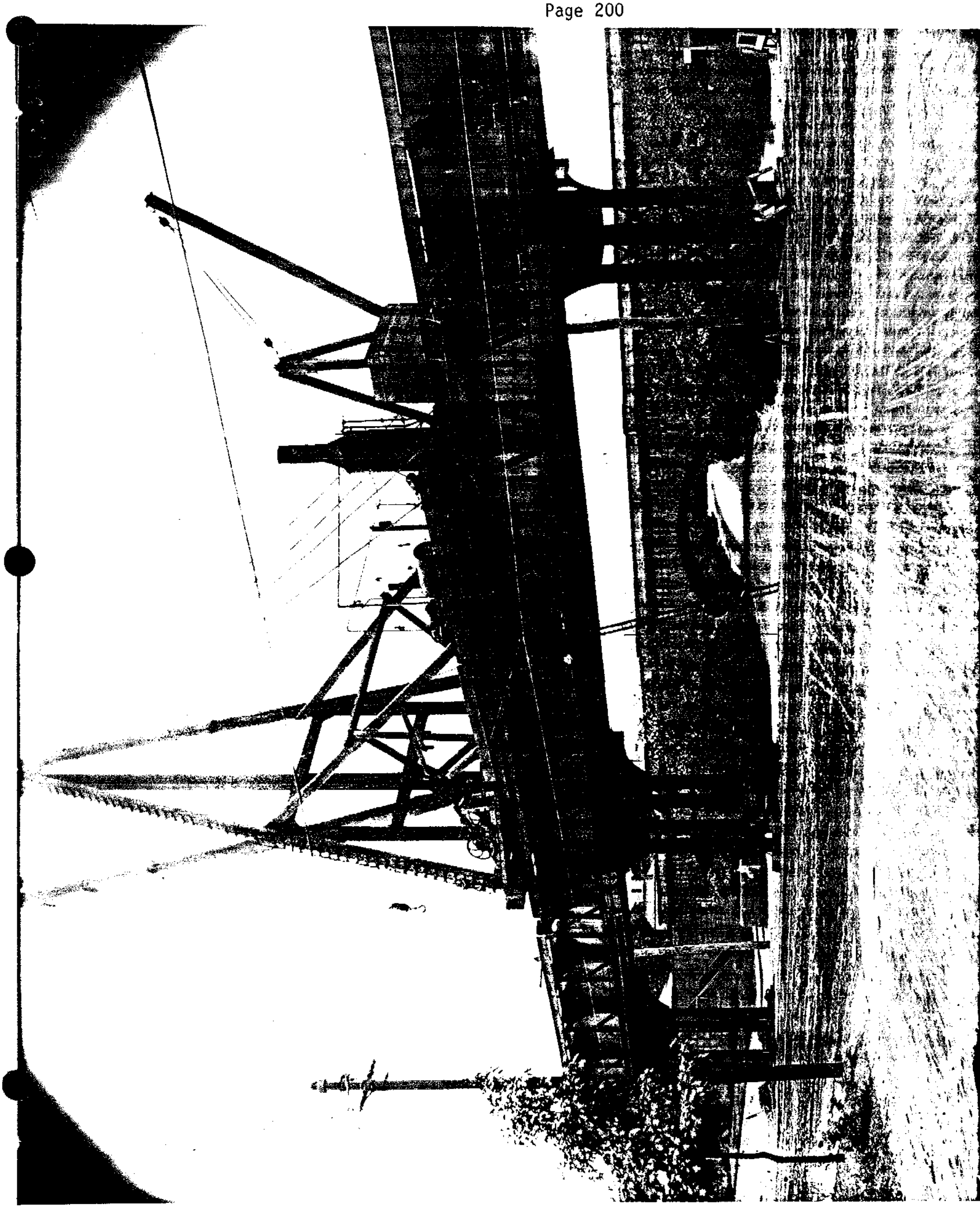

Foundation W. side of W ington S Burnett St.
May 25.
6043

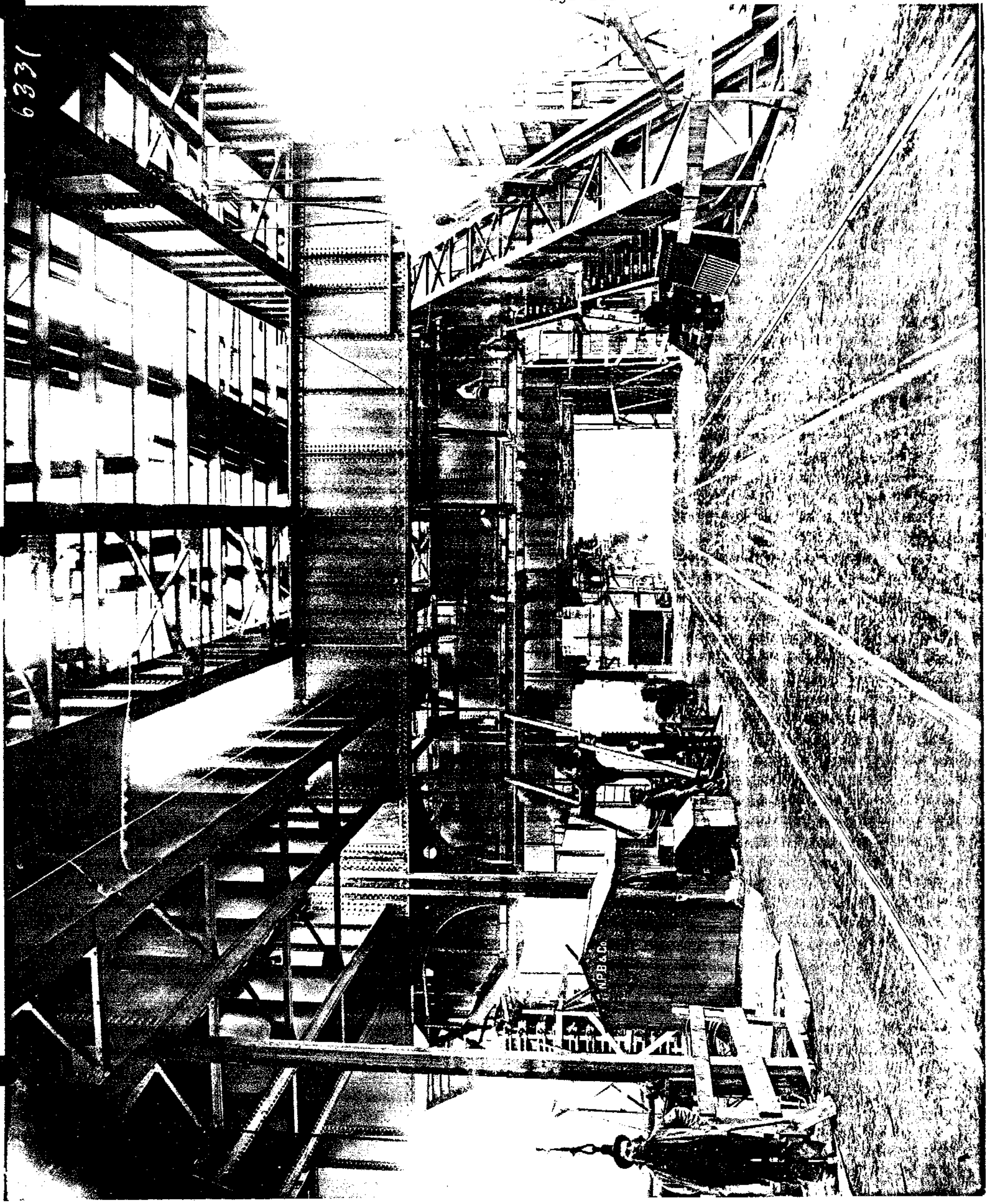


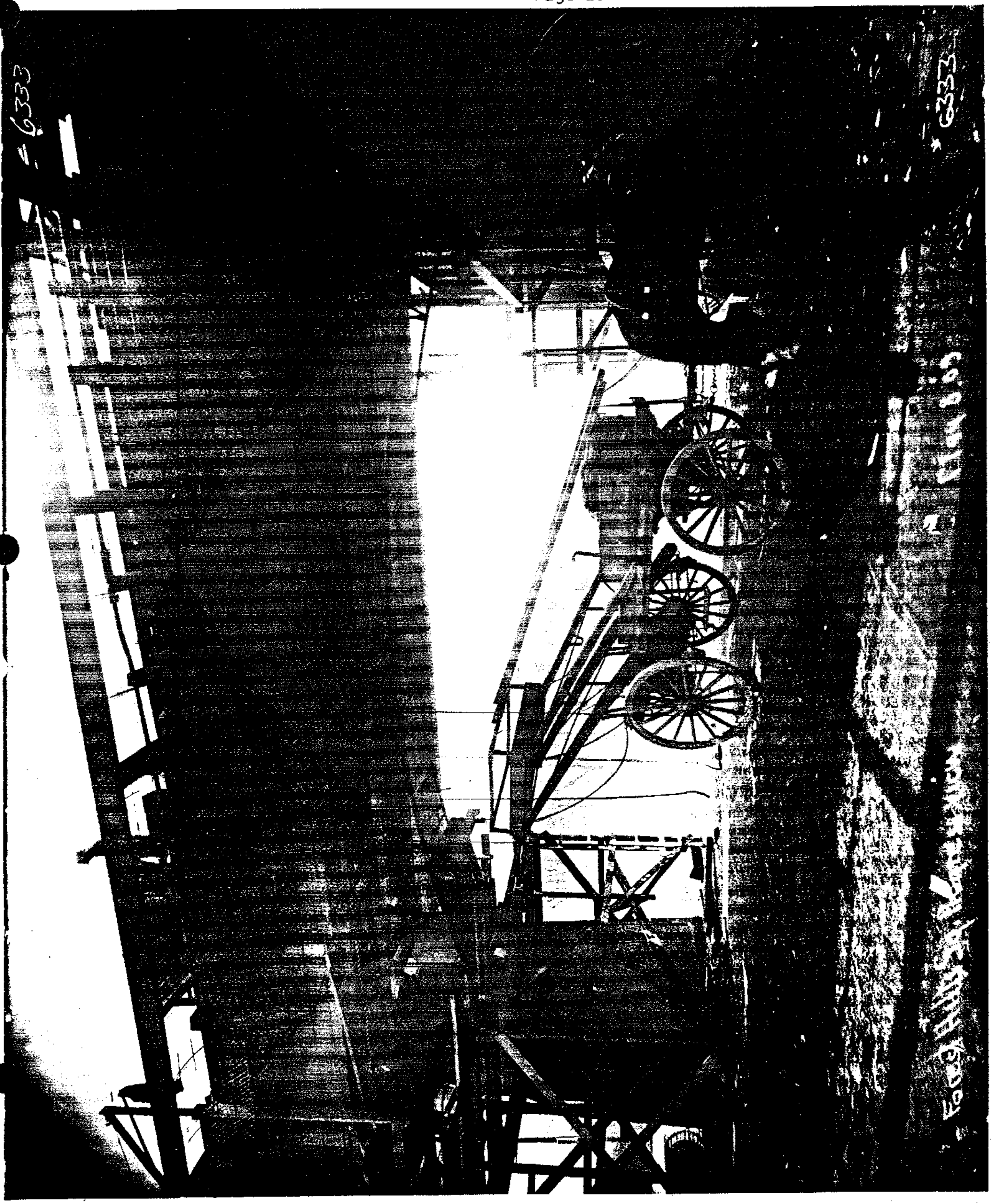

6218
Forest Hills


Forest Hills Sq

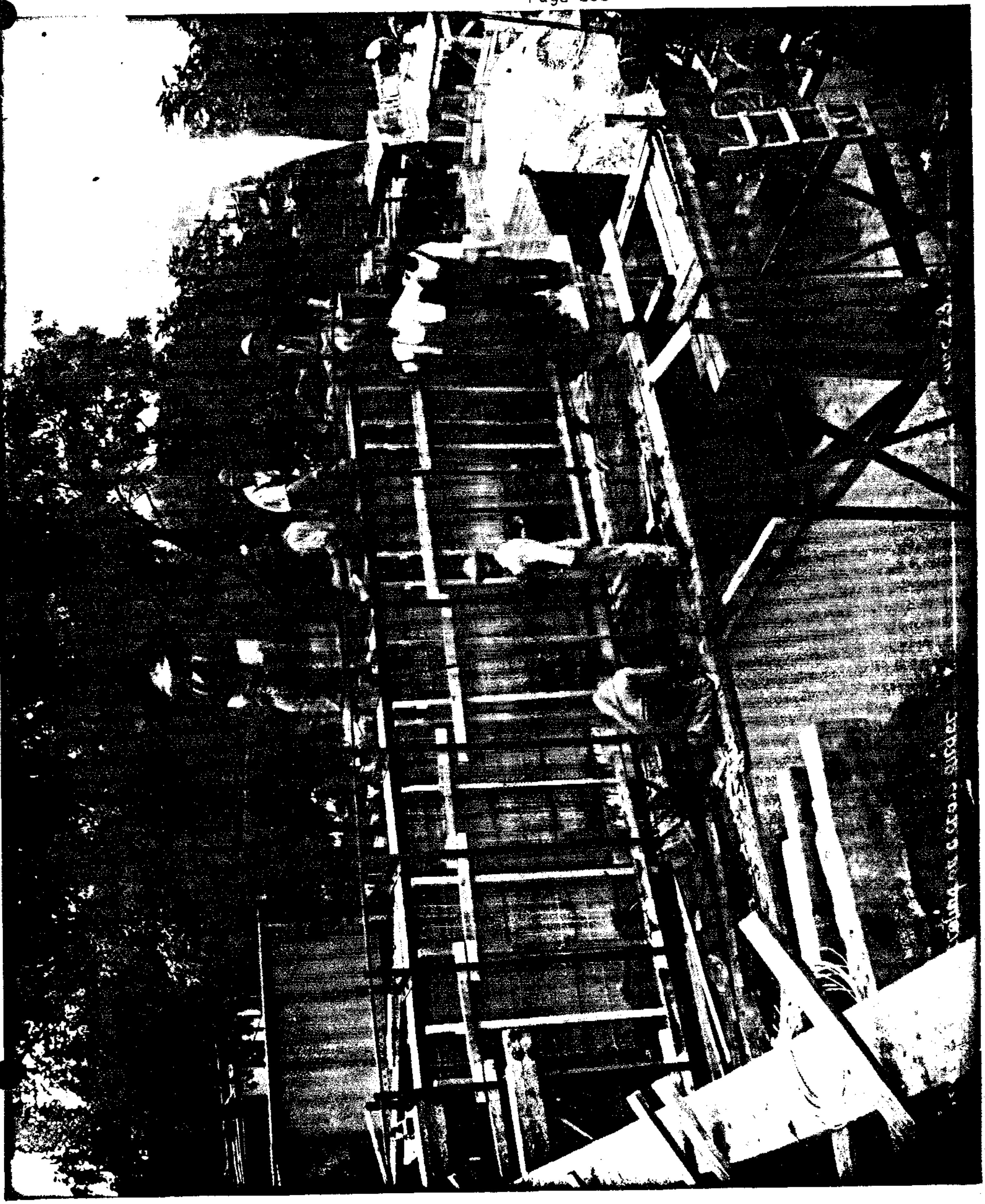

METROPOLITAN
COAL
COMPANY



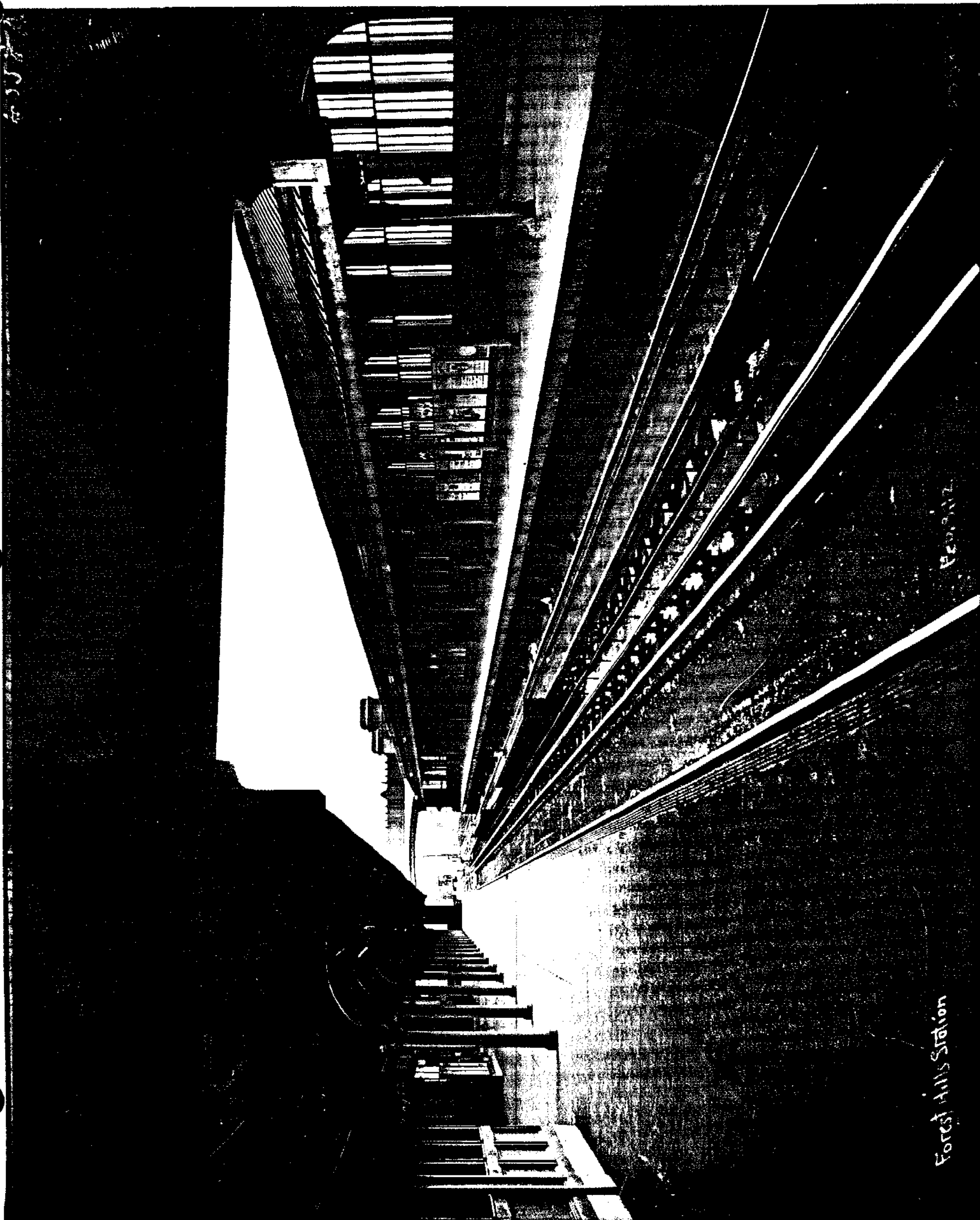


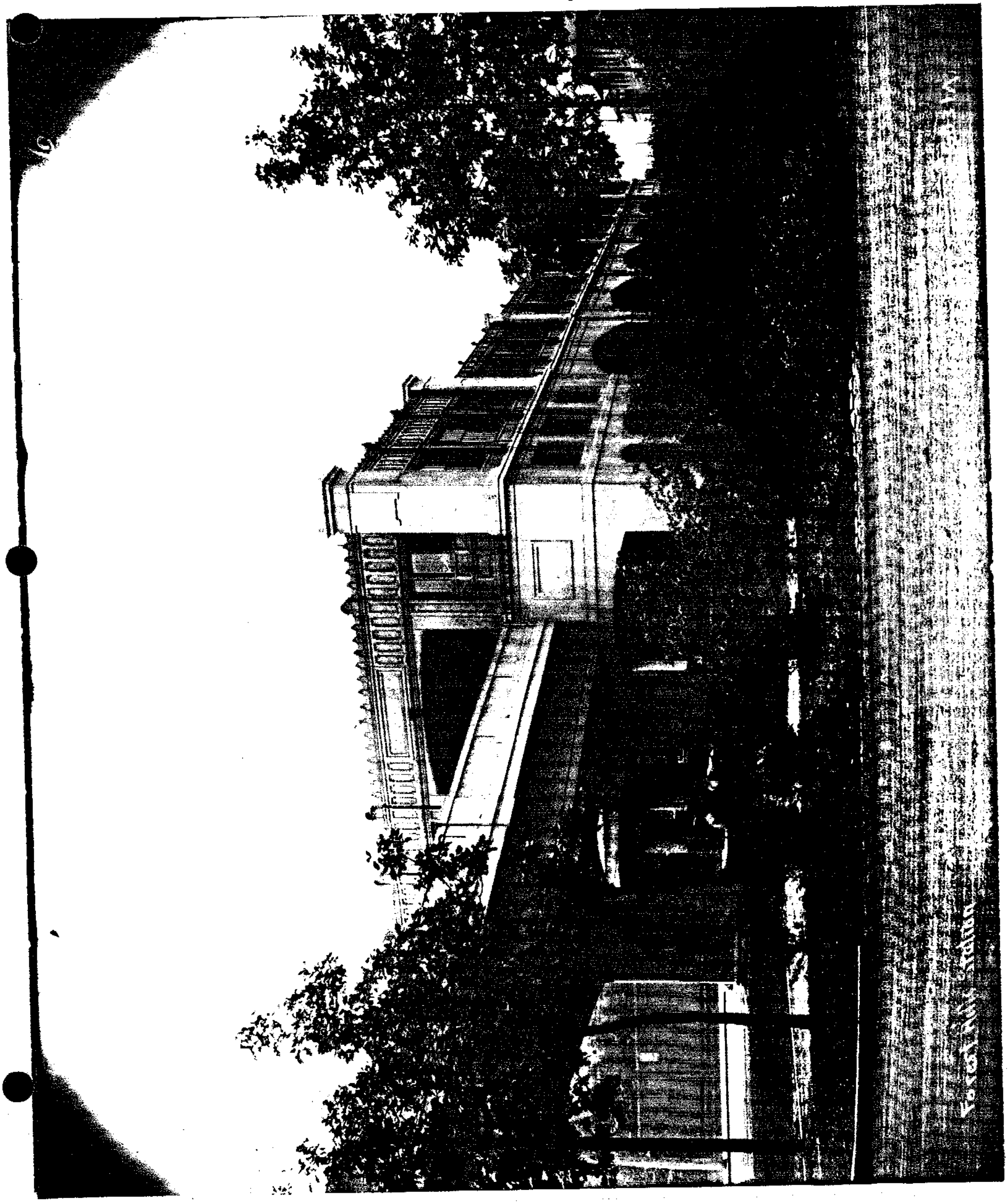

6333
6333

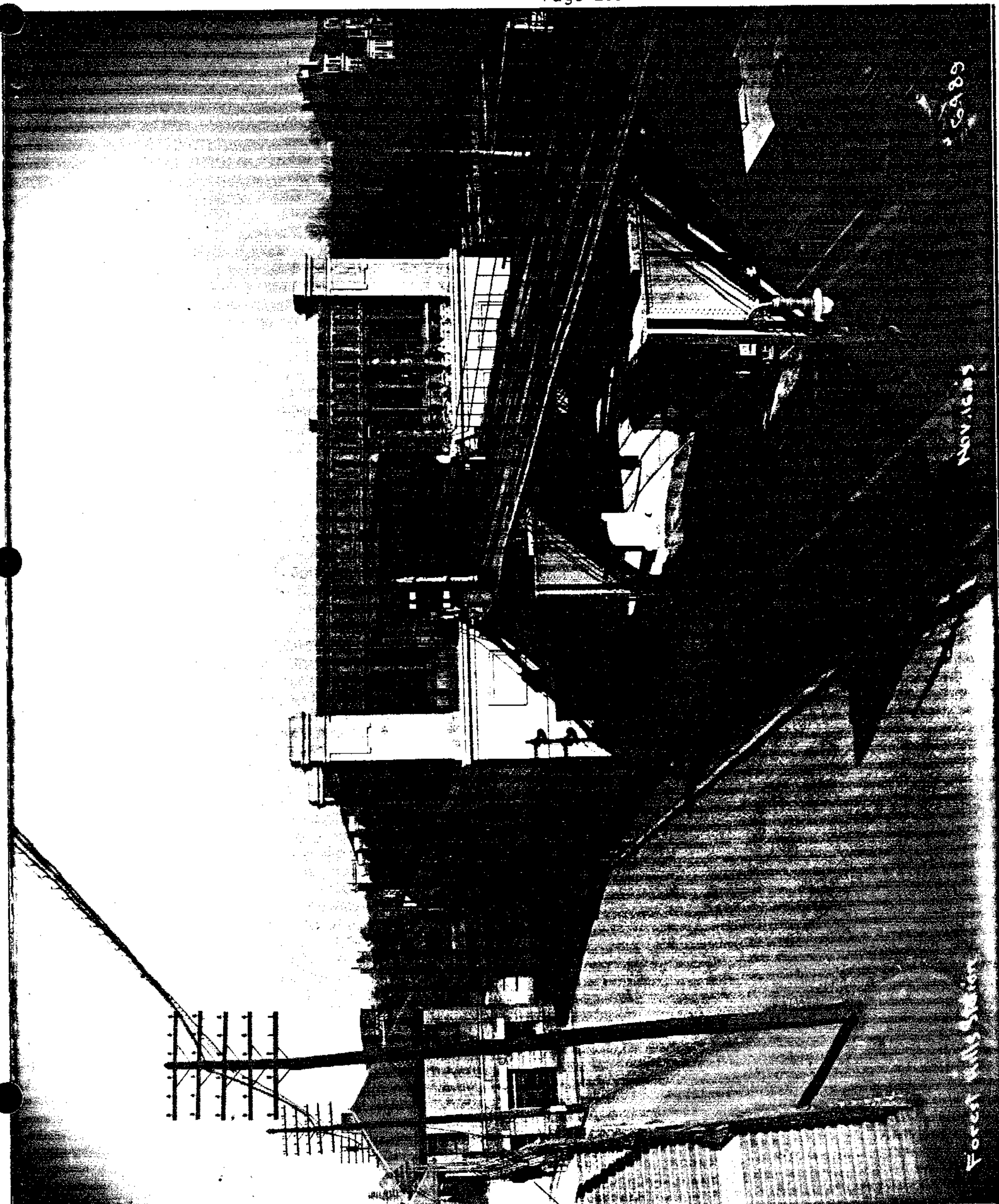

Forest Hills Sq. Progress.

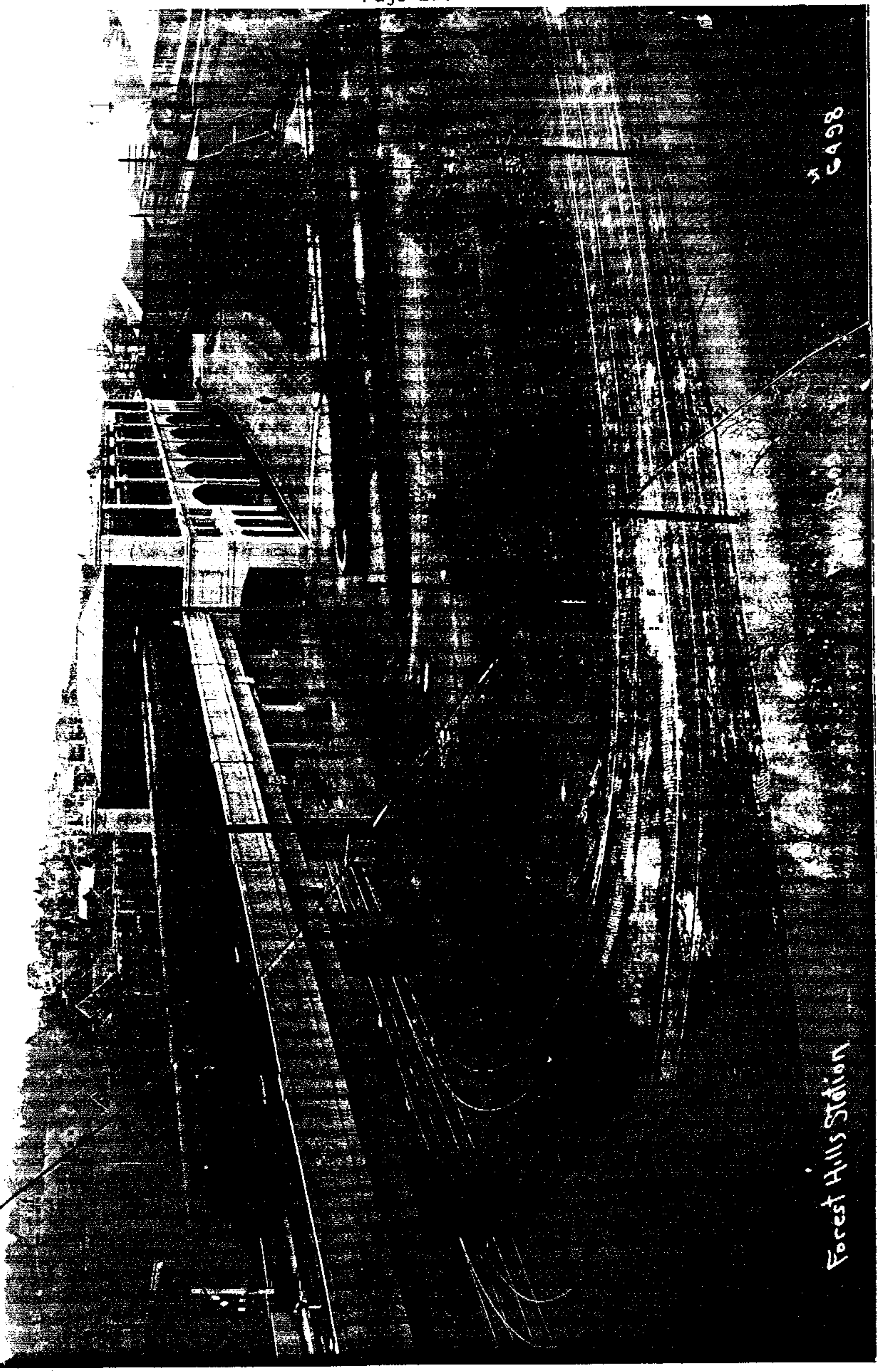


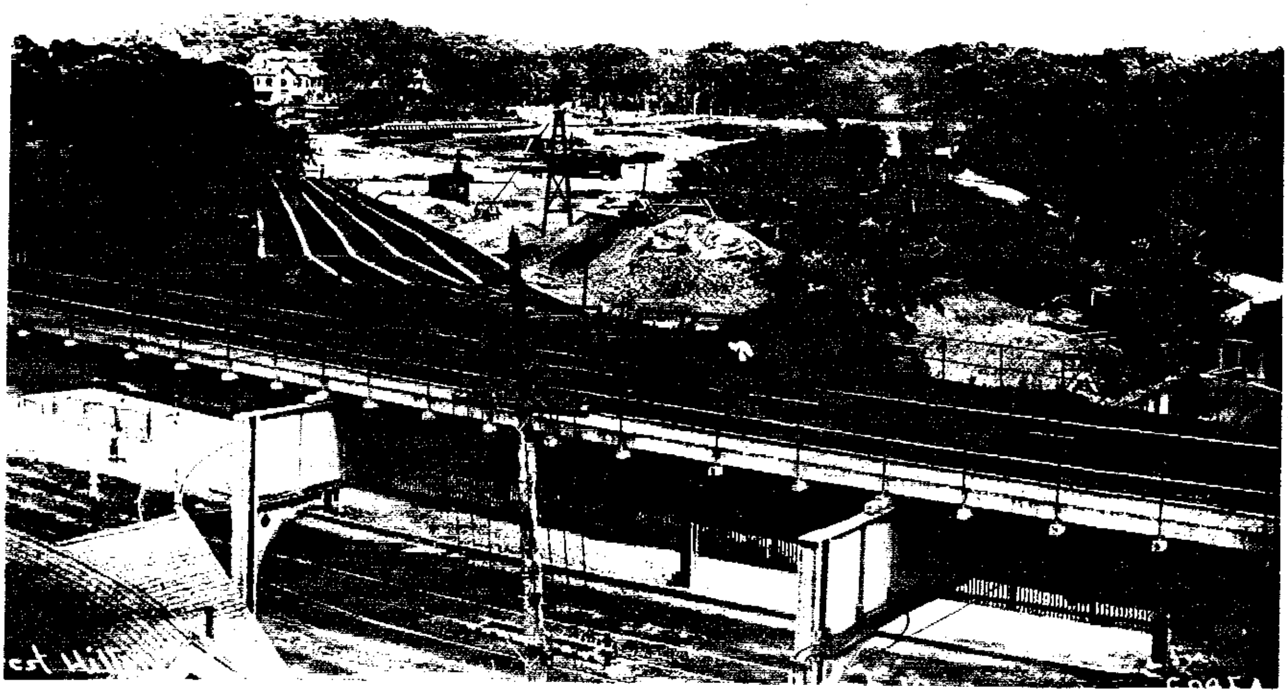

June 1.09
6275


Forest Hills Station




Forest Hills Station
6989


Forest Hills Station



APPENDIX D

List of Historic Drawings

Original Architectural and Engineering drawings from which these copies were made are in the plan files of the Massachusetts Bay Transportation Authority (MBTA) Engineering Department, Boston, Mass. Access and use of these drawings currently (1986) is restricted and may be reproduced only with the owner's permission.

Structural Drawings

HAER Number	Description	Date	Original BERy Drawing Number
HD-1	Map of Mainline between Dudley Street Roxbury and Sullivan Sq., Charlestown.	1903	-
HD-2	Map of Rapid Transit Lines - Forest Hills to Sullivan Square.	1913	26455
HD-3	Map of Forest Hills and Roxbury Sections of the Mainline.	April 9, 1956	M-a-15946
HD-4	Map of the Charlestown-Everett Section and Washington Street Tunnel.	April 9, 1956	M-a-15947
HD-5	Map of Elevated Lines - Distances between Stations, Length of Platforms, Capacity of Car Houses & Sidings.	June 1901	10863
HD-6	Map of Pleasant Street Connection.	-	20801
HD-7	Map of Boston Neighborhood Populations Serving the Boston Elevated Systems.	Feb. 23, 1910	38098
HD-8	Elevated Railway Foundations Compiled by Boston Elevated Railway.	1905	3748A
HD-9	Typical Foundation Drawing for Roxbury Mainline.	June 10, 1899	11235
HD-10	General Drawing Bents #112-#121: Roxbury Division Concord Street to Newton Street.	Feb. 21, 1899	25676

Structural Drawings

HAER Number	Description	Date	Original BERy Drawing Number
HD-11	Plan Typical Portion of Mainline along Washington Street: Bents #11D-#122.	1899	25656
HD-12	General Plan: Bents #4D-#66 Mainline between Garfield Street and Harrison Avenue.	April 21, 1899	25652
HD-13	Typical Longitudinal Girder - 12 panels.	Dec. 21, 1897	2D258
HD-14	Typical Lateral Bracing Steelwork No. 3.	Dec. 28, 1897	2D254
HD-15	Typical Elevations and Cross-Sections - Showing Form and Methods of Construction of Elevated Mainline Structure.	Dec. 21, 1897	20252
HD-16	Typical Cross Girder 'A' - Tracks out of Centre.	March 4, 1899	2D286
HD-17	Typical Cross Girder, Elevation of Cross Truss and Posts-Design 'A'.	Dec. 27, 1897	2D259
HD-18	Typical Cross Girder Oesign 'E' Elevation of Cross Girder and Posts.	Dec. 18, 1897	2D256
HD-19	Design 'F' Typical Arched Bent Elevation of Cross Truss.	Dec. 14, 1897	20258
HD-20	Design 'F' Preliminary Study Orawing, Plan, Elevation and Section.	Feb. 8, 1898	-
HD-21	Typical Cross Truss'L'.	Jan. 28, 1899	2D277
HO-22	Typical Cross Truss 'N'.	Jan. 28, 1899	20279
HO-23	Typical Cross Girder 'O'.	Jan. 27, 1899	20280
HD-24	Typical Cross Girder 'P'.	Jan. 27. 1899	20281
HD-25	Details of Cross Girders and Posts: Bents #19 & #20 Roxbury Division.	April 15, 1899	25713

Structural Drawings

HAER Number	Description	Date	Driginal BERy Drawing Number
HD-26	Roxbury Division - Details of Dpen Webbed Cross-Girder Bent #6D.	April 26, 1899	25716
HD-27	Roxbury Division - Details of Bent #96.	Mar. 29, 1899	2D294
HD-28	Roxbury Division - Bents #2D5 & #2O6 - Typical of Bents along the Pleasant Street Extension.	Jan. 1899	2O323
HD-29	Roxbury Division - Cross Girders & Posts Bents #1212-#1218.	Oct. 1899	2D33D
HD-30	South Approach - Washington Street Tunnel. Transverse Girders & Columns - Bents #1232-#124D.	Mar. 19D6	25737
HD-31	South Approach - Washington Street Tunnel. Diagrams of Bents #123D-#1231-#1233-#1234-#1238-#1239-#1241-#1242.	Mar. 19D6	25743
HD-32	South Approach - Washington Street Tunnel. Foundations for Columns - Bents #1227-#1228-#1229.	Mar. 19D7	2D575
HD-33	Roxbury Division. Foundation for Post #1DDDE - Washington Street at Circuit Street - Showing Utility Pipes passing under foundation.	Jan. 31, 19D2	11419
HD-34	Dudley Street Terminal - Cross Section of Loop Structure with Deck Girders.	Feb. 6, 1899	26373
HD-35	Detailed Plan of Wye at Dudley & Washington Streets.	1899	13D1D
HD-36	Drawing - Typical Foundation - Forest Hills Extension.	Feb. 23, 19D6	11423
HD-37	Plan - Forest Hills Extension.	Nov. 21, 19D4	26454
HD-38	Forest Hills Extension - Diagram of Bents #778-#782.	Feb. 19D8	26764

Structural Drawings

HAER Number	Description	Date	Original BERy Drawing Number
HD-39	Forest Hills Extension - Details of Bent #783.	April 19D8	26722
HD-40	Forest Hills Extension - Plan of Foundations 836E & 837W - Stony Brook near Williams Street.	Sept. 21, 1906	20574
HD-41	Forest Hills Section - Details at Cross Girder #887.	Sept. 17, 1929	-
HD-42	Forest Hills Extension - Diagram for 8ents #920-#932 - Showing Stiffeners.	April 21, 1905	26714
HD-43	Plan - Washington Street. Forest Hills to 4D0 Feet North of Arborway. Section F-6.		26751
HD-44	Forest Hills Extension - Bents #791-#796 over Arborway - Showing Steel Plate Structure Encased in Reinforced Concrete.	Mar. 1908	26751 26766
HD-45	Forest Hills Extension - Details of Reinforced Concrete Encased Bent #797 above the Arborway.	Apr. 1909	26789
HD-46	Forest Hills Extension - Details of Reinforced Concrete above the Arborway.	Apr. 1909	26786
HD-47	Forest Hills Extension - Details of Reinforced Concrete Bents #790 & #797.	Apr. 1909	26790
HD-48	Forest Hills Extension - General Drawing - Bents #798-#804 Plan and Elevation Showing Abandoned Ramp to Former Arborway Storage Yard.	Jan. 1908	26754
HD-49	Forest Hills Yard Leads - Layout of Steelwork - Bent #800E to #FH6 - Plan and Elevation of Ramp to Arborway Storage Yard.	Sept. 1909	29600

List of Historic Drawings

Architectural Orawings

HAER Number	Oescription	Oate	Original BERy Drawing Number
HO-50	Oover Street - Station Plan of Main and Intermediate Platforms.	July 20, 1960	37421
HO-51	Oover Street Station Contract Plan - Original Center Platform Layout.	Aug. 7, 1900	21650
HO-52	Oover Street Station - Sections and Interior Elevations. (A.W. Longfellow jr. Architect)	1900	21652
HO-53	Plan, Cross Section, and Elevation of Standard Platform Canopy.	March 4, 1899	20297
HO-54	Steelwork at Oover Street Station for Center Platform Layout.	June 21, 1898	20300
HO-55	Oover Street Station - Elevations of Canopy Roof - Entrance Stairs. (A.W. Longfellow jr. Architect)	April 23, 1901	27370
HO-56	Oover Street Station - Oetails of Ticket Office. (A.W. Longfellow jr. Architect)	1900	21659
HD-57	Dover Street Station - Section through Side Wall. (A.W. Longfellow jr. Architect)	1900	21653
HO-58	Oover Street Station - Plans and Elevations of Modifications and Changes for a New Station.	April 1911	-
HO-59	Oover Street Station- Additions and Reconstruction Elevations.	Aug. 1912	28237
HD-60	Cross Section of a Typical Center Platform "Island" Station. (Commonly used on First Phases of Mainline Construction).	1899	-
HO-61	Northampton Street Station - Platform Plan and East Elevation.	Aug. 6, 1900	21604

List of Historic Drawings

Architectural Drawings

HAER Number	Description	Date	Original BERy Drawing Number
HD-62	Northampton Street Station - Plan & Elevations. (A.W. Longfellow jr. Architect)	1899	216DD
HD-63	Sections thru Northampton and Dover Street Stations Showing Details of Plumbing.	Dec. 17, 1900	21612
HD-64	Dudley Street Terminal - General Plan.	Dec. 9, 1898	25355
HD-65	Dudley Street Station - Surface Plan.	19D2	27566
HD-66	Dudley Street Station - Elevations.	1899	-
HD-67	Dudley Street Station - Cross Section - Central Waiting Room. (A.W. Longfellow jr. Architect)	19DD	21533
HD-68	Dudley Street Station - East Elevation. (A.W. Longfellow jr. Architect)	19DD	21561
HD-69	Dudley Street Station - North Elevation & Cupola Details. (A.W. Longfellow jr. Architect)	190D	21562
HD-7D	Dudley Street Station - North Elevation of Northeast Waiting Room. (A.W. Longfellow jr. Architect)	19DD	21564
HD-71	Dudley Street Station - Transverse Section thru Centre of Central Waiting Room.	190D	21567
HD-72	Dudley Street Terminal - Cross Section of Building at Bent #T16.	March 13, 1899	26386
HD-73	Dudley Street Station - Elevations & Sections Showing Proposed Changes.	Dec. 19D6	2758D
HD-74	Dudley Street Station - Elevated Level Plan Showing Proposed Changes.	Aug. 19D9	27583

List of Historic Drawings

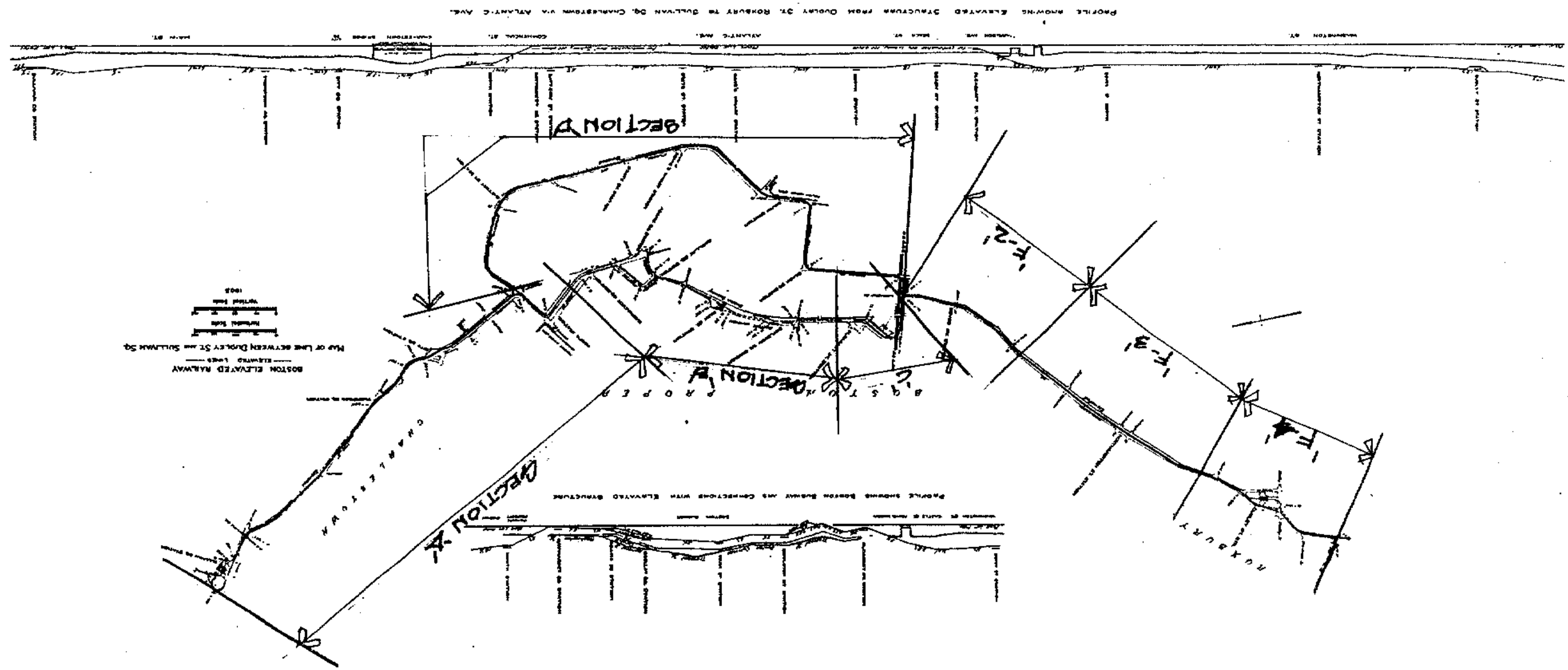
Architectural Drawings

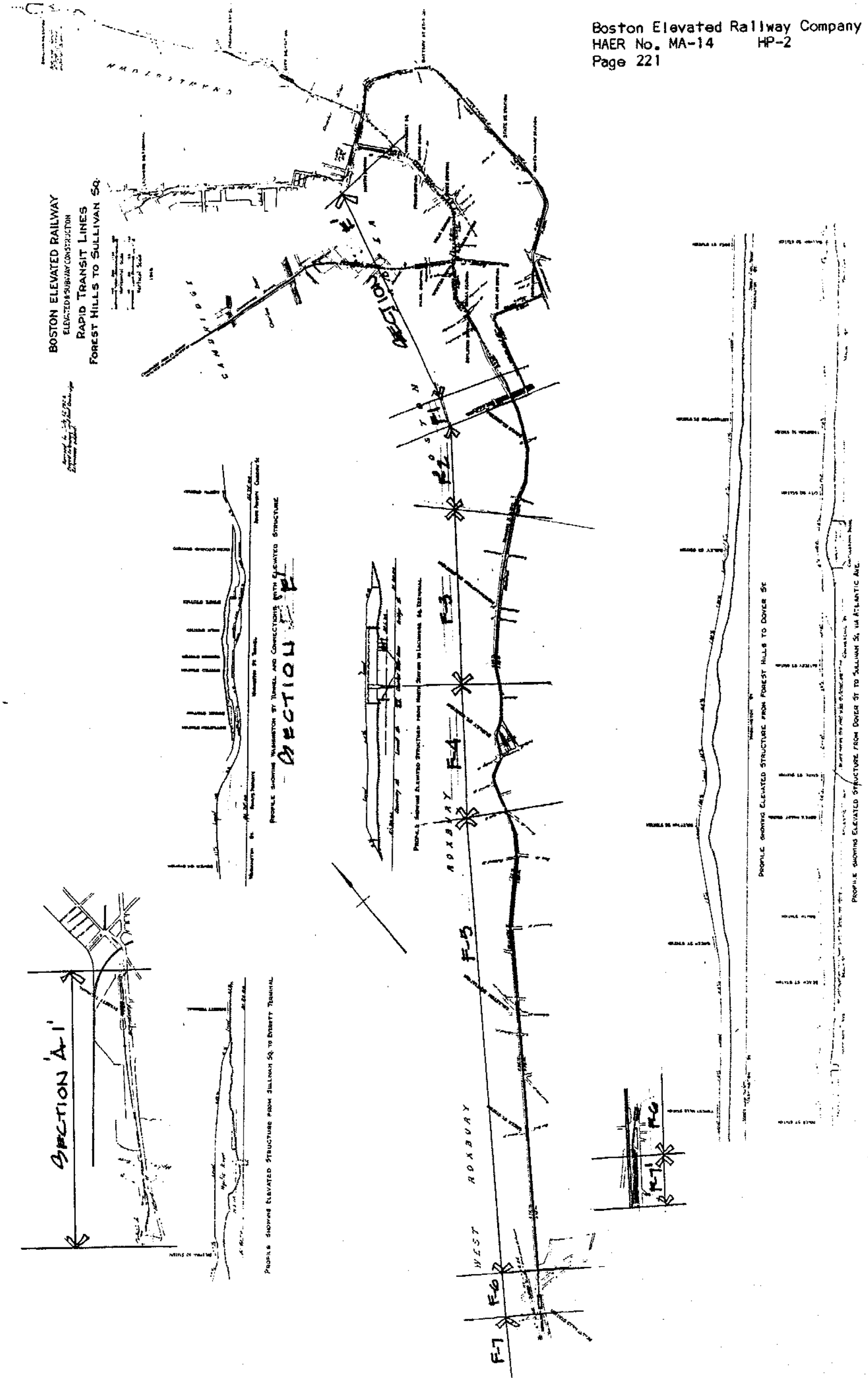
HAER Number	Description	Date	Original BERy Drawing Number
HD-75	Dudley Street Station - Surface Level.	Aug. 1911	27588
HD-76	Dudley Street Station - Elevated Level.	Aug. 1911	27589
HD-77	Roxbury Division - Elevation - Bartlett Street Switch Tower.	June 26, 1901	21919
HD-78	Dudley Street Station - Platform Plan - Showing Reconstruction of East Loop.	Nov. 7, 1973	74825
HD-79	Dudley Street Station - Lower Level Plan.	April 3, 1949	37419
HD-80	Egleston Square - Station Plan.	March 24, 1961	37417-1
HD-81	Egleston Square Station - Plan & Elevations.	Dec. 1906	28380
HD-82	Egleston Square Station - Sections & Elevations at Gallery.	Dec. 1906	28382
HD-83	Egleston Square Station - Interior Details & Section thru Canopy at Enclosure.	Dec. 1906	28391
HD-84	Egleston Square Station - Surface Plan Showing Addition for Surface Car Station.	May 1916	28619
HD-85	Egleston Square Station - Enlargement - Elevation on Columbus Avenue of Surface Car Station.	May 1916	28621
HD-86	Green Street - Station Plan.	June 16, 1960	37416
HD-87	Green Street Station - Sections and Elevations of Waiting Room.	Jan. 1912	35085
HD-88	Green Street Station - Sections and Interior Elevations.	Jan. 1912	35087

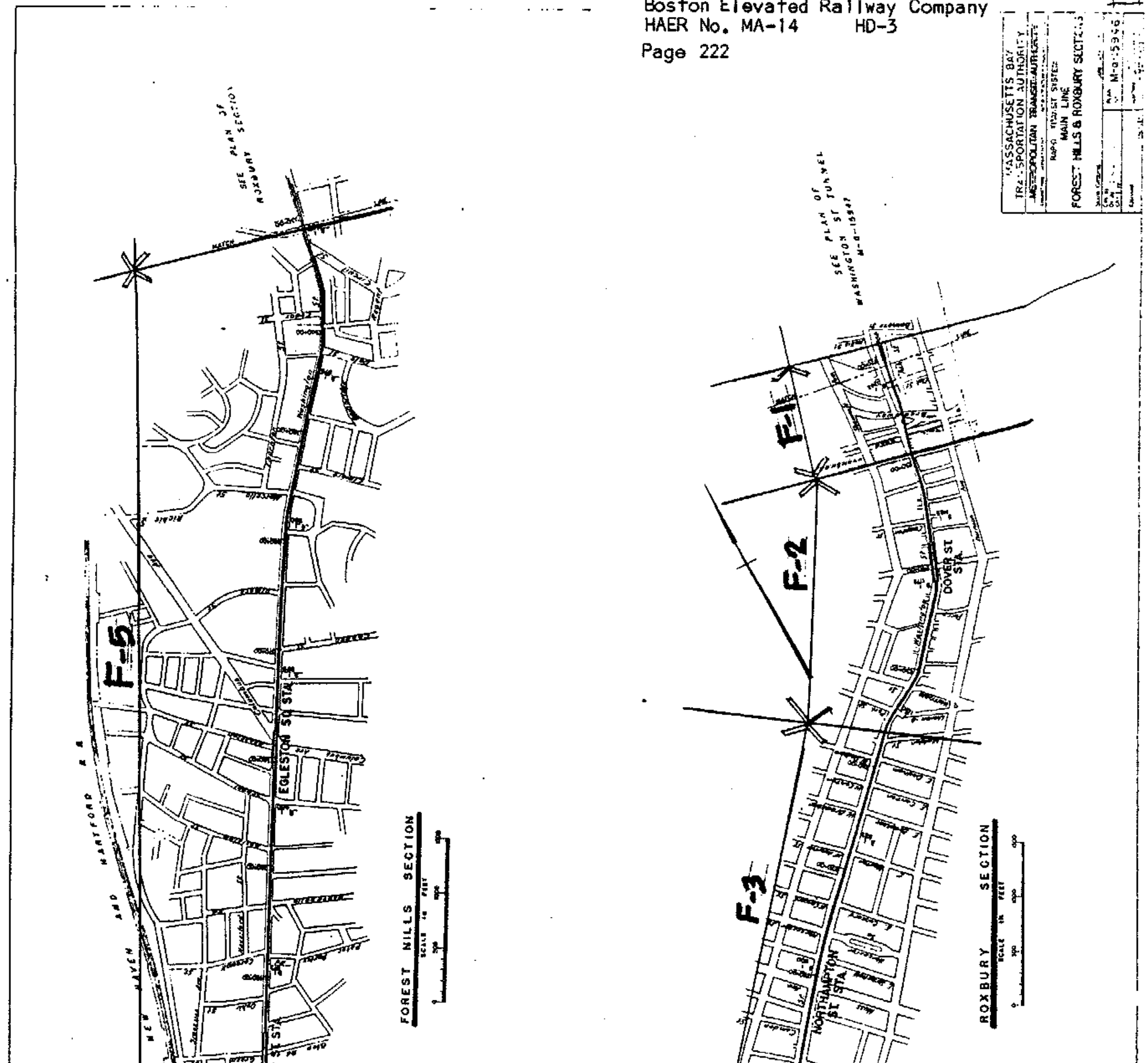
List of Historic Orawings

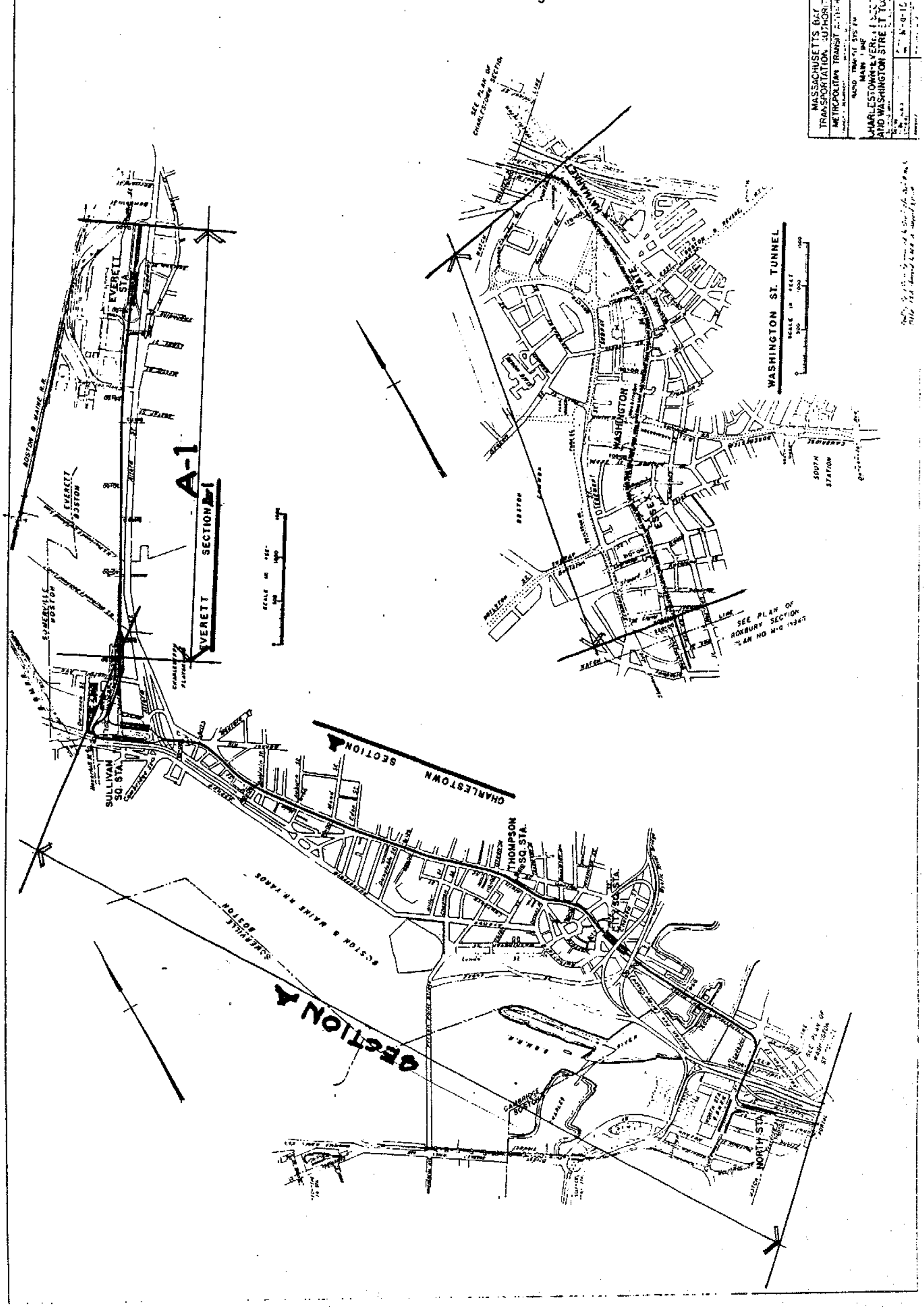
Architectural Drawings

HAER Number	Description	Oate	Original BERy Orawing Number
HO-89	Green Street Station - Details of Elevation and Section.	Jan. 1912	35089
HO-90	Forest Hills Station - Plan of Surface Level.	Sept. 15, 1909	28676
HO-91	Forest Hills Station - Plan of Elevated Level.	Sept. 1911	28688
HO-92	Forest Hills Station - Surface Level Plan.	Sept. 1911	28689
HD-93	Forest Hills Station - Elevations and Section.	Feb. 1909	-
HO-94	Forest Hills Station - Longitudinal Elevations through Platform Bents #783-#786.	Oct. 1908	28160
HO-95	Forest Hills Station - Detail Concrete Form Work for North Wall of Station.	July 1909	28672
HO-96	Forest Hills Station - Details of Reinforced Concrete Bents #784-#788.	June 1909	28658
HD-97	Forest Hills Station - Interior Elevations - East Elevated Platform.	Sept. 1909	28675
HO-98	Forest Hills Station - Details of Reinforced Concrete North and South Pavillions.	April 1909	28657
HO-99	Forest Hills Station - Details of Form Work for First Story Pilasters Span 790. Span 784 is similar.	April 1909	28659
HO-100	Map of Streetcar Lines prior to Construction of Rapid Transit Systems.	1885	-


SECTION A
SECTION B
SECTION C
SECTION A'
F-1
F-2
F-3
CHARLESTOWN
BOSTON PROPER
ROXBURY


BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
RAPID TRANSIT LINES
FOREST HILLS TO SULLIVAN SQ.
CAMBRIDGE
BOSTON
ROXBURY
WEST ROXBURY
SECTION 'E'
SECTION 'A 1'
F-1
F-2
F-3
F-4
F-5
F-6
F-7
PROFILE SHOWING WASHINGTON ST TUNNEL AND CONNECTIONS WITH ELEVATED STRUCTURE
PROFILE SHOWING ELEVATED STRUCTURE FROM SULLIVAN SQ. TO EVERETT TERMINAL
PROFILE SHOWING ELEVATED STRUCTURE FROM FOREST HILLS TO DOVER ST
PROFILE SHOWING ELEVATED STRUCTURE FROM DOVER ST TO SULLIVAN SQ. VIA ATLANTIC AVE.


MASSACHUSETTS BAY TRANSPORTATION AUTHORITY
METROPOLITAN TRANSIT AUTHORITY
RAPID TRANSIT SYSTEM
MAIN LINE
FOREST HILLS & ROXBURY SECTIONS
FOREST HILLS SECTION
ROXBURY SECTION
EGLESTON SQ STA
GREEN ST STA
FOREST HILLS STA
DOVER ST STA
NORTHAMPTON ST STA
DUDLEY ST STA
NEW YORK NEW HAVEN AND HARTFORD R R
SEE PLAN OF ROXBURY SECTION
SEE PLAN OF WASHINGTON ST TUNNEL
F-1
F-2
F-3
F-4
F-5
F-6
F-7


MASSACHUSETTS BAY TRANSPORTATION AUTHORITY
EVERETT STA.
EVERETT SECTION A-1
BOSTON & MAINE R.R.
SULLIVAN SQ. STA.
CHARLESTOWN SECTION A
THOMPSON SQ. STA.
CITY SQ. STA.
SECTION A
NORTH STA.
WASHINGTON ST. TUNNEL
WASHINGTON
SOUTH STATION
SEE PLAN OF ROXBURY SECTION

BOSTON ELEVATED RAILWAY

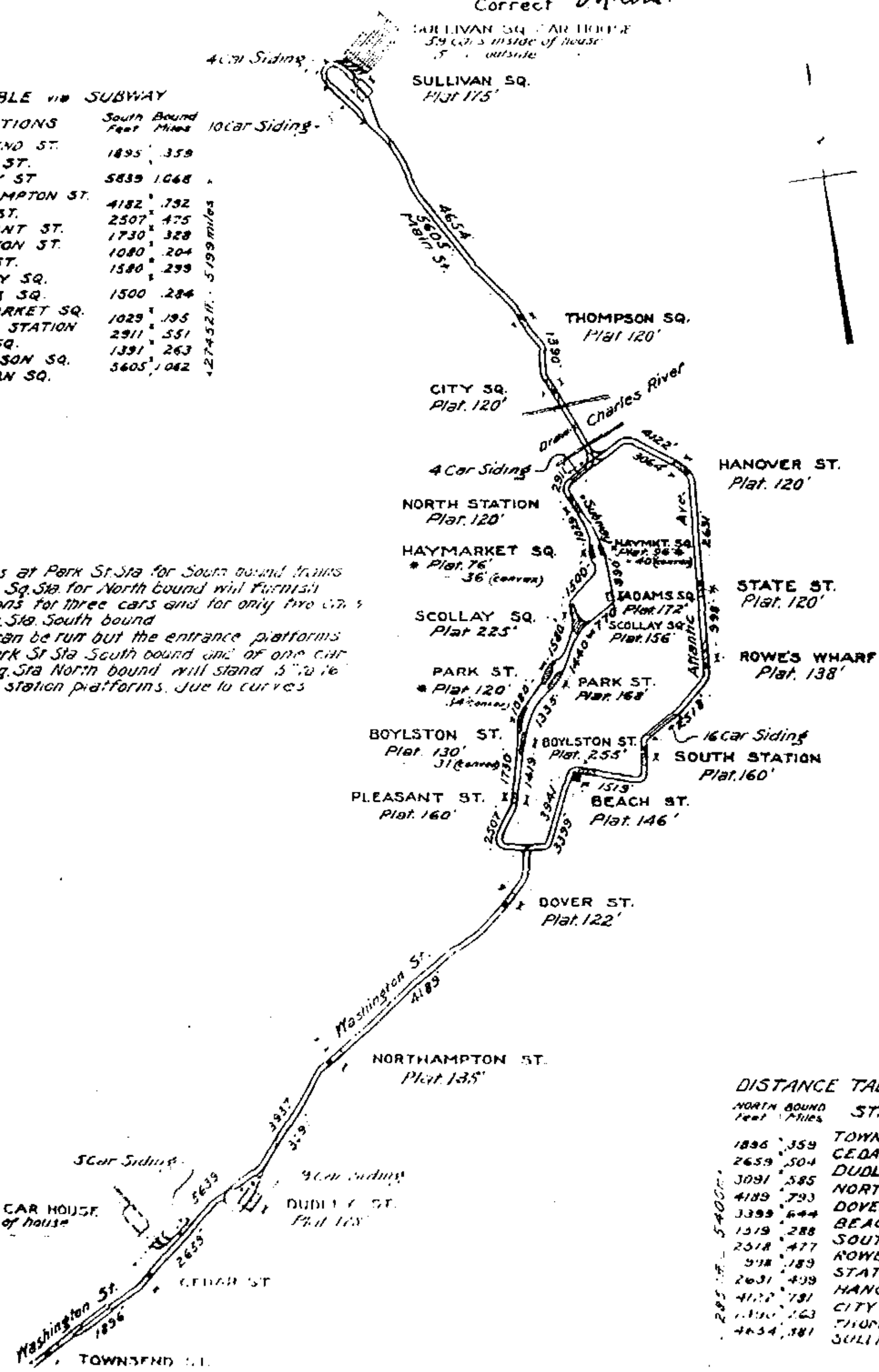
ELEVATED LINES

DISTANCES BETWEEN STATIONS, LENGTH OF PLATFORMS, CAPACITY OF CAR HOUSES & SIDINGS

Approx. Scale 2500' = 1"
June 1901.

Correct E.K. Olin.

George A. Kimball
Chief Engineer.



DISTANCE TABLE via SUBWAY

North Bound Feet	North Bound Miles	STATIONS	South Bound Feet	South Bound Miles
		TOWNSEND ST.		
1896	.359		1895	.359
		CEDAR ST.		
2655	.504			
		DUDLEY ST	5839	1.068
3081	.586			
		NORTHAMPTON ST.		
4189	.793		4182	.792
		DOVER ST.		
2517	.477		2507	.475
		PLEASANT ST.		
1419	.269		1730	.328
		BOYLSTON ST.		
1335	.253		1080	.204
		PARK ST.		
1440	.273		1580	.299
		SCOLLAY SQ.		
770	.146			
		ADAMS SQ.	1500	.284
990	.187			
		HAYMARKET SQ.		
1072	.203		1029	.195
		NORTH STATION		
2887	.547		2911	.551
		CITY SQ.		
1330	.263		1391	.263
		THOMPSON SQ.		
4654	.881		5605	1.062
		SULLIVAN SQ.		

North bound total: 25754 ft. = 4.877 miles
South bound total: 27452 ft. = 5.199 miles

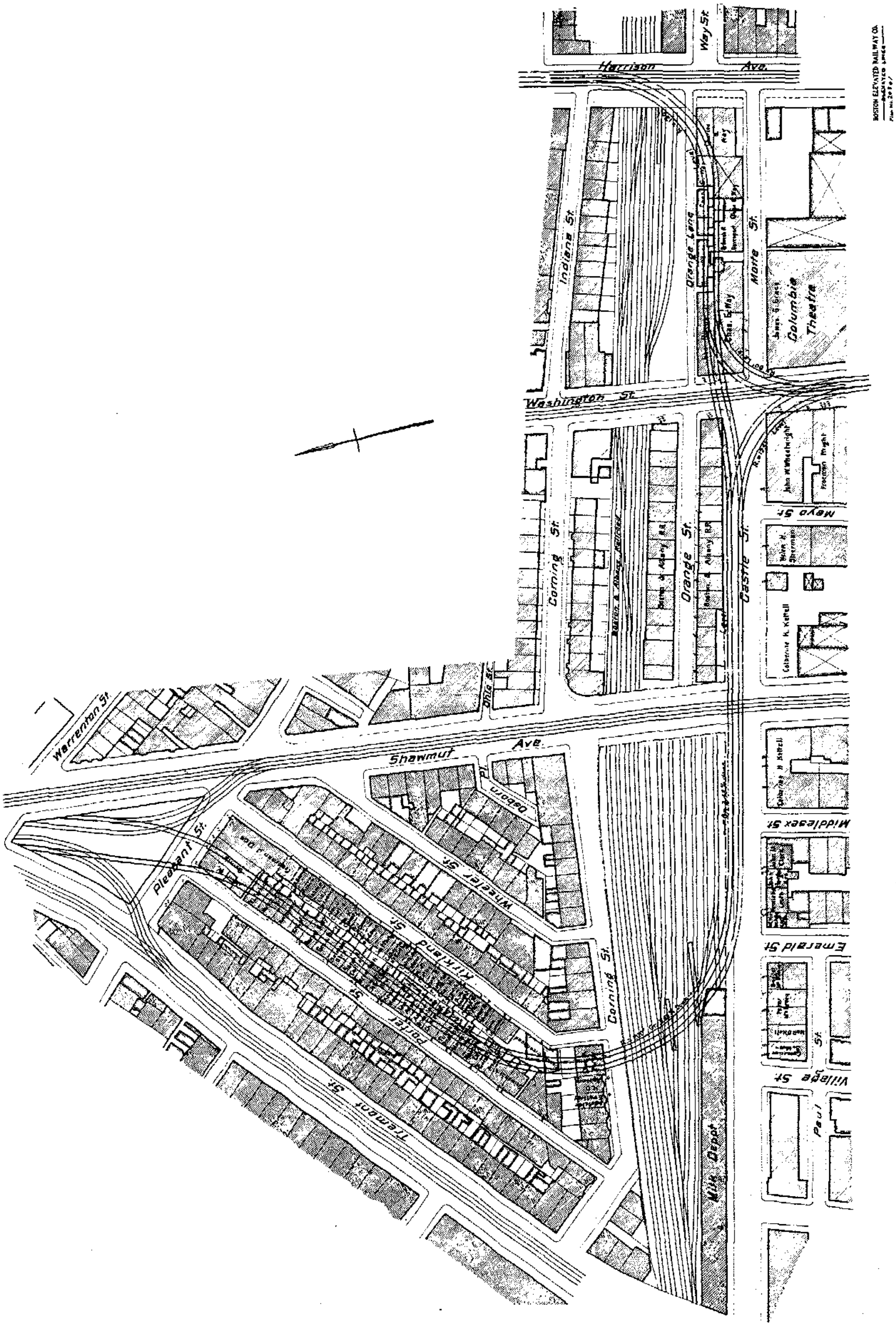
* The platforms at Park St. Sta. for South bound trains and at Haymarket Sq. Sta. for North bound will furnish good accomodations for three cars and for only two cars at Haymarket Sq. Sta. South bound.
Four car trains can be run but the entrance platforms of two cars at Park St. Sta. South bound and of one car at Haymarket Sq. Sta. North bound will stand 5" to 16" away from the station platforms due to curves in tracks.

DISTANCE TABLE via ATLANTIC AVE.

North Bound Feet	North Bound Miles	STATIONS	South Bound Feet	South Bound Miles
		TOWNSEND ST.		
1896	.359		1895	.359
		CEDAR ST.		
2659	.504			
		DUDLEY ST.		
3091	.585		3937	.746
		NORTHAMPTON ST.		
4189	.793		4182	.792
		DOVER ST.		
3399	.644		3437	.651
		BEACH ST.		
1519	.288		1487	.282
		SOUTH STATION		
2518	.477		2508	.475
		ROWE'S WHARF		
998	.189		998	.189
		STATE ST.		
2631	.499		2613	.495
		HANOVER ST.		
4122	.781		4117	.780
		CITY SQ.		
[illegible]	.263		1331	.263
		THOMPSON SQ.		
4654	.881		5605	1.062
		SULLIVAN SQ.		

North bound total: 285[illegible] ft. – 5.40[illegible]
South bound total: 30275 ft. = 5.735 m.

10863


Harrison Ave.
Way St.
Indiana St.
Orange Lane
Columbia Theatre
Washington St.
Corning St.
Orange St.
Castle St.
Mayo St.
Middlesex St.
Emerald St.
Village St.
Paul St.
Shawmut Ave.
Warrenton St.
Pleasant St.
Wheeler St.
Kirkland St.
Porter St.
Tremont St.
Corning St.

A – SERVED BY EAST BOSTON TUNNEL

B – SERVED BY ELEVATED (NORTH) AND WASHINGTON ST. TUNNEL

C – TO BE SERVED BY CAMBRIDGE SUBWAY AND EAST CAMBRIDGE ELEVATED

D – TO BE SERVED BY RIVERBANK SUBWAY AND RESERVATION LINES

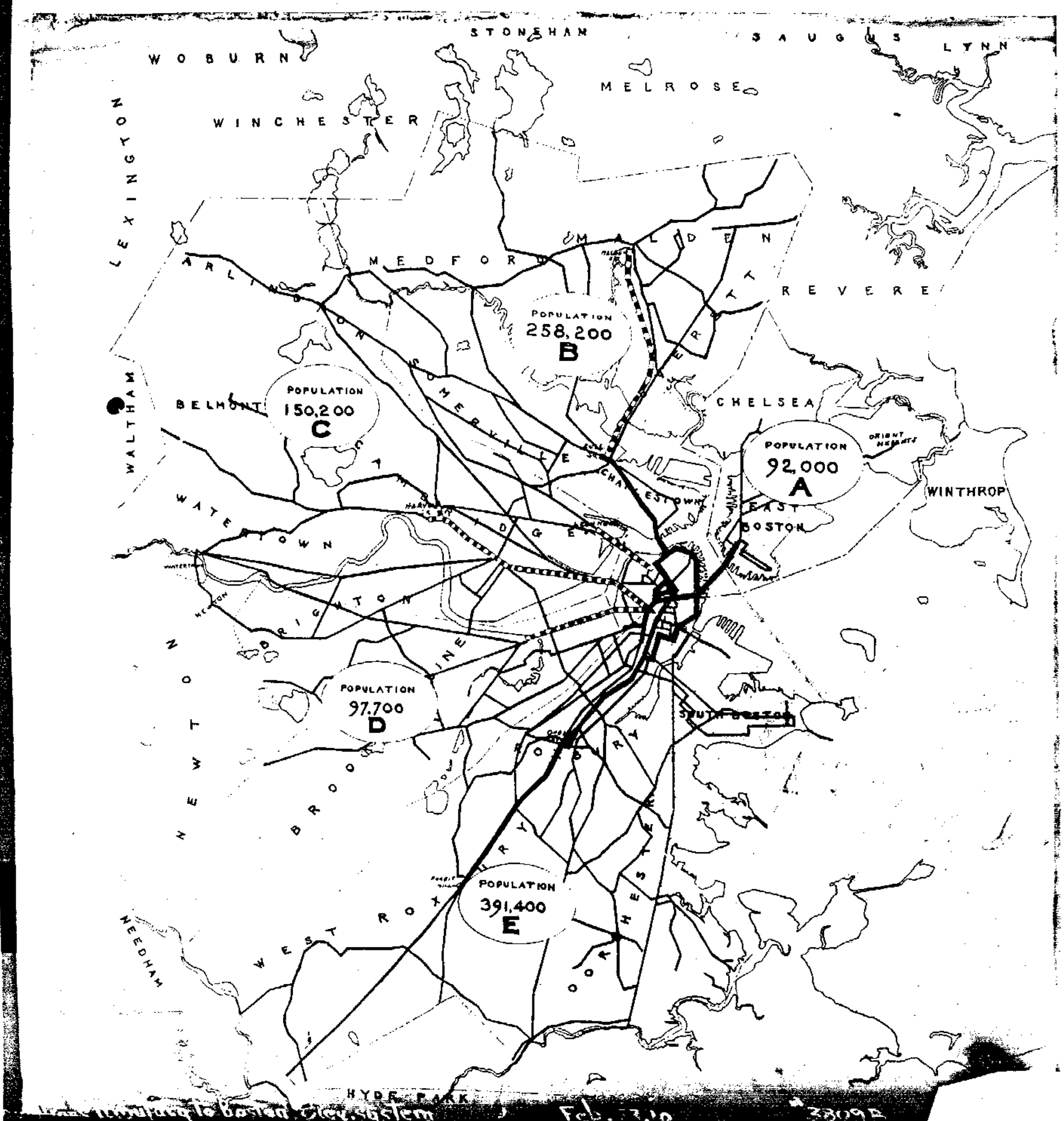
E – SERVED BY ELEVATED (SOUTH) AND WASHINGTON ST. TUNNEL

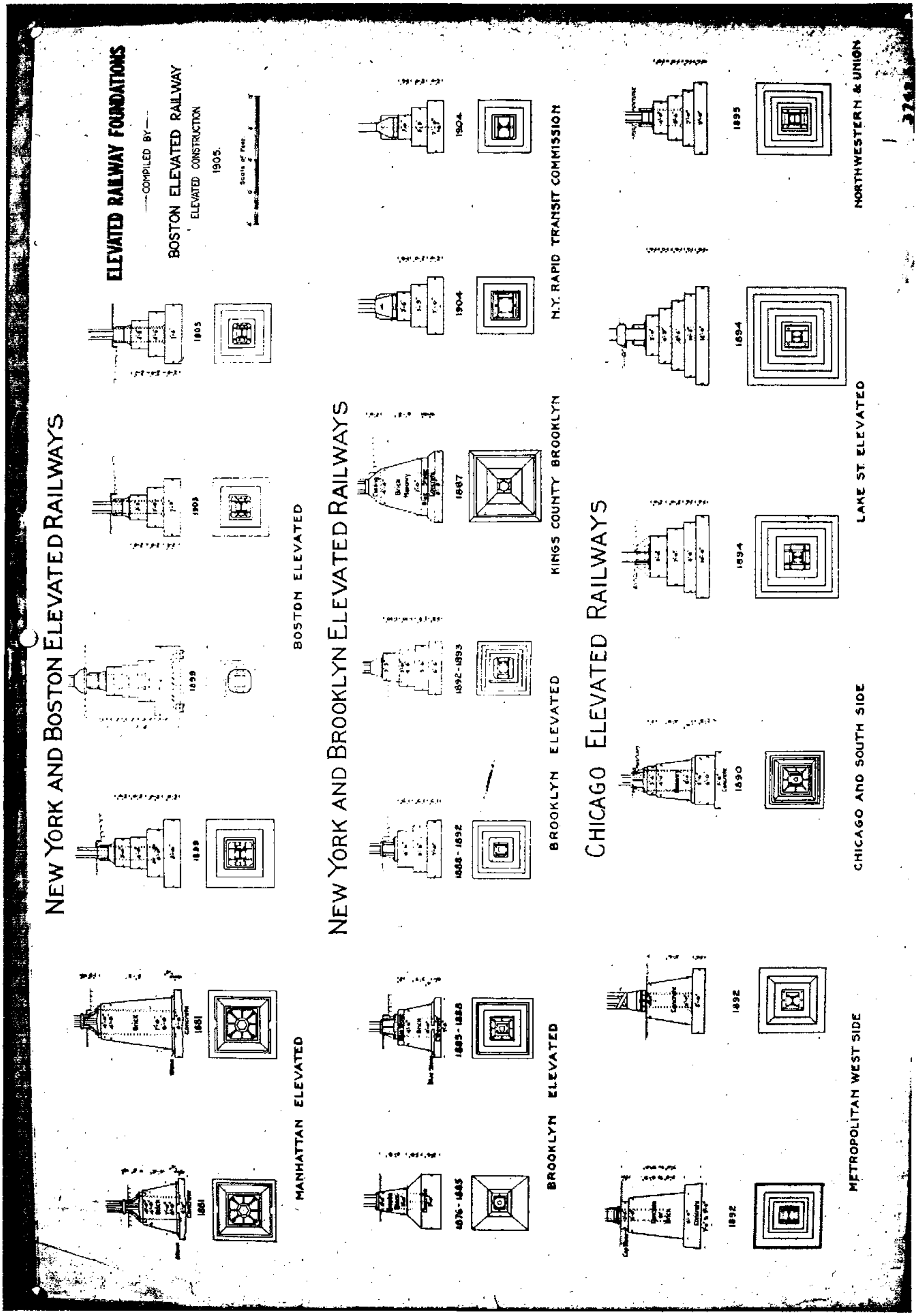
ALL RAPID TRANSIT LINES SUPPLEMENTED BY SURFACE LINES

SURFACE TRACKS SHOWN THUS:

EXISTING SUBWAYS AND ELEVATED LINES SHOWN THUS:

PROPOSED SUBWAYS AND ELEVATED LINES SHOWN THUS:




ELEVATED RAILWAY FOUNDATIONS
—COMPILED BY—
BOSTON ELEVATED RAILWAY
ELEVATED CONSTRUCTION
1905.
NEW YORK AND BOSTON ELEVATED RAILWAYS
1881
1881
MANHATTAN ELEVATED
1899
1899
1903
1905
BOSTON ELEVATED
NEW YORK AND BROOKLYN ELEVATED RAILWAYS
1876-1885
1885-1888
BROOKLYN ELEVATED
1888-1892
1892-1893
BROOKLYN ELEVATED
1887
KINGS COUNTY BROOKLYN
1904
1904
N.Y. RAPID TRANSIT COMMISSION
CHICAGO ELEVATED RAILWAYS
1892
1892
METROPOLITAN WEST SIDE
1890
CHICAGO AND SOUTH SIDE
1894
1894
LAKE ST. ELEVATED
1895
NORTHWESTERN & UNION

BOSTON ELEVATED RAILWAY

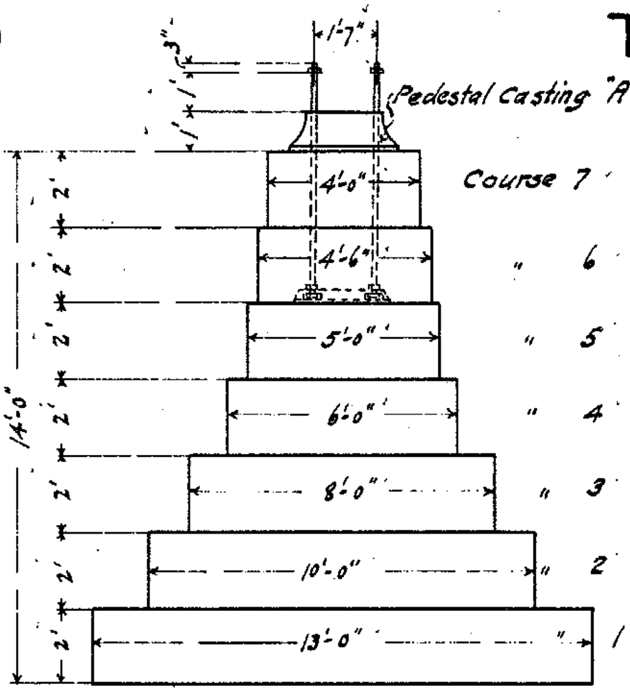
—— ELEVATED LINES ——

TYPICAL FOUNDATION

BASE 13'0" X 13'0" 7 COURSES

Scale: $\frac{1}{4}$" = 1'   June 10, 1899

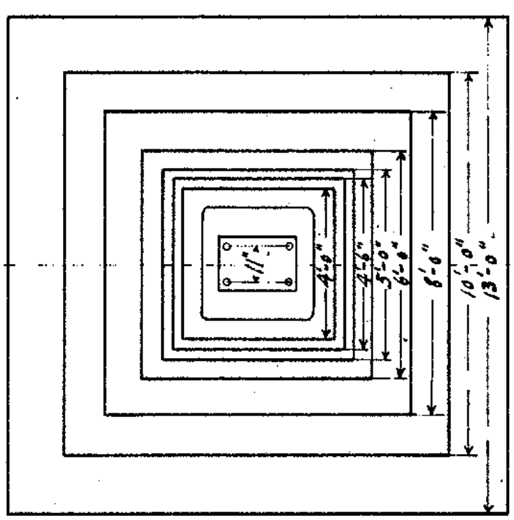
George A. Kimball
CHIEF ENGINEER



Foundation to be Portland Cement Concrete mixed in proportions as follows:-

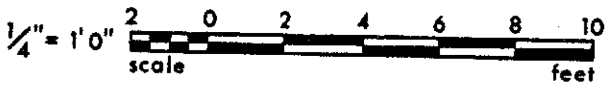
Courses	1-3	1:3:6
"	4-6	1:2½:5
"	7	1:1:3

ELEVATION



center line of Bent

PLAN



11235

D9

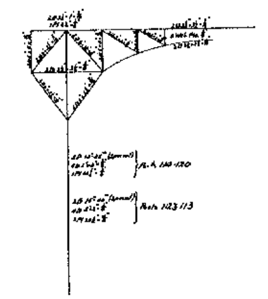
BOSTON ELEVATED RAILWAY
— ELEVATED LINES —
ROXBURY DIV.
CONCORD ST. TO NEWTON ST.
GENERAL DRAWING BENTS 112-121
Scale ⅛ in. = 1 ft. Feb. 21. 1899.

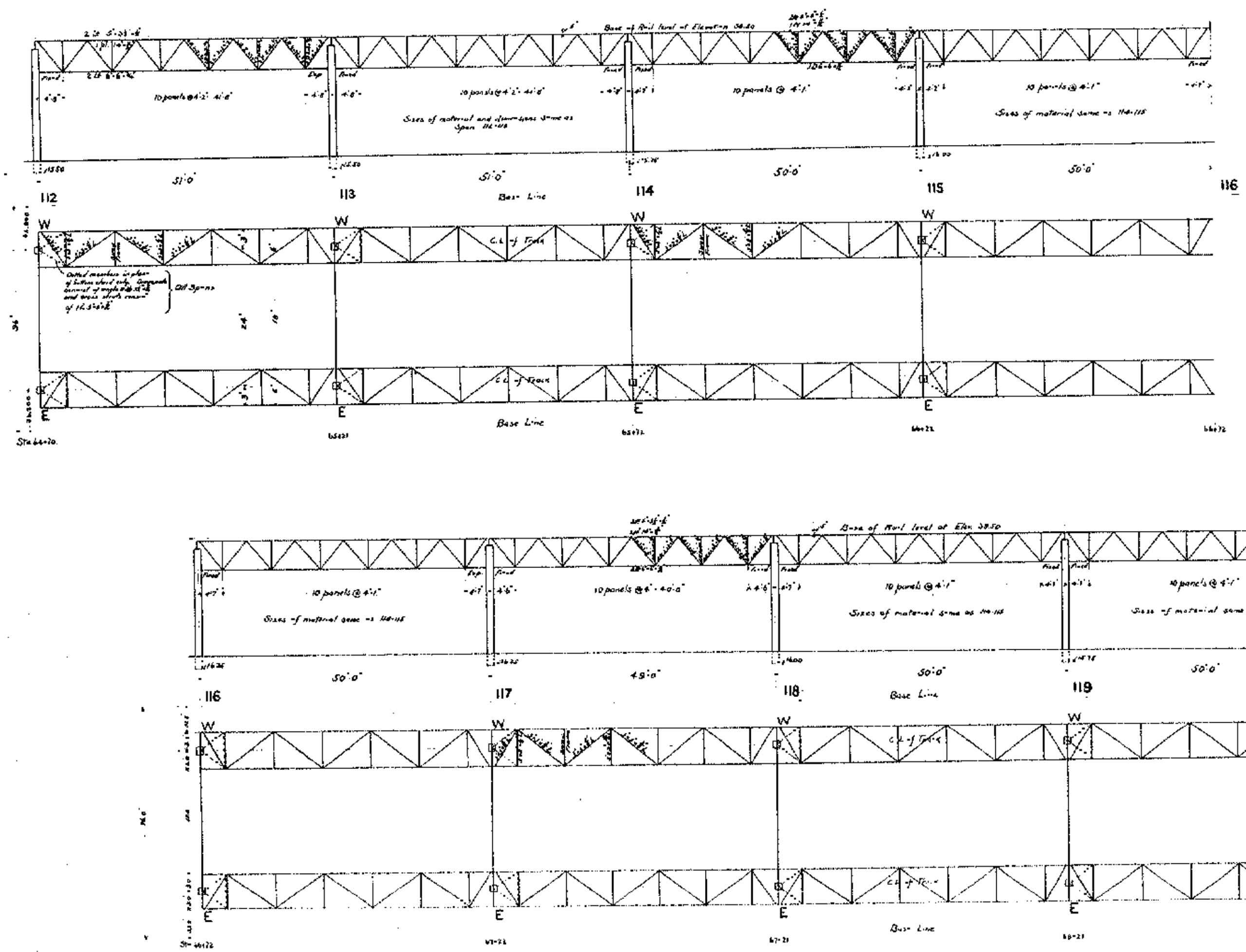
J. R. Worcester
Designing Engineer

George A. Kimball
CHIEF ENGINEER

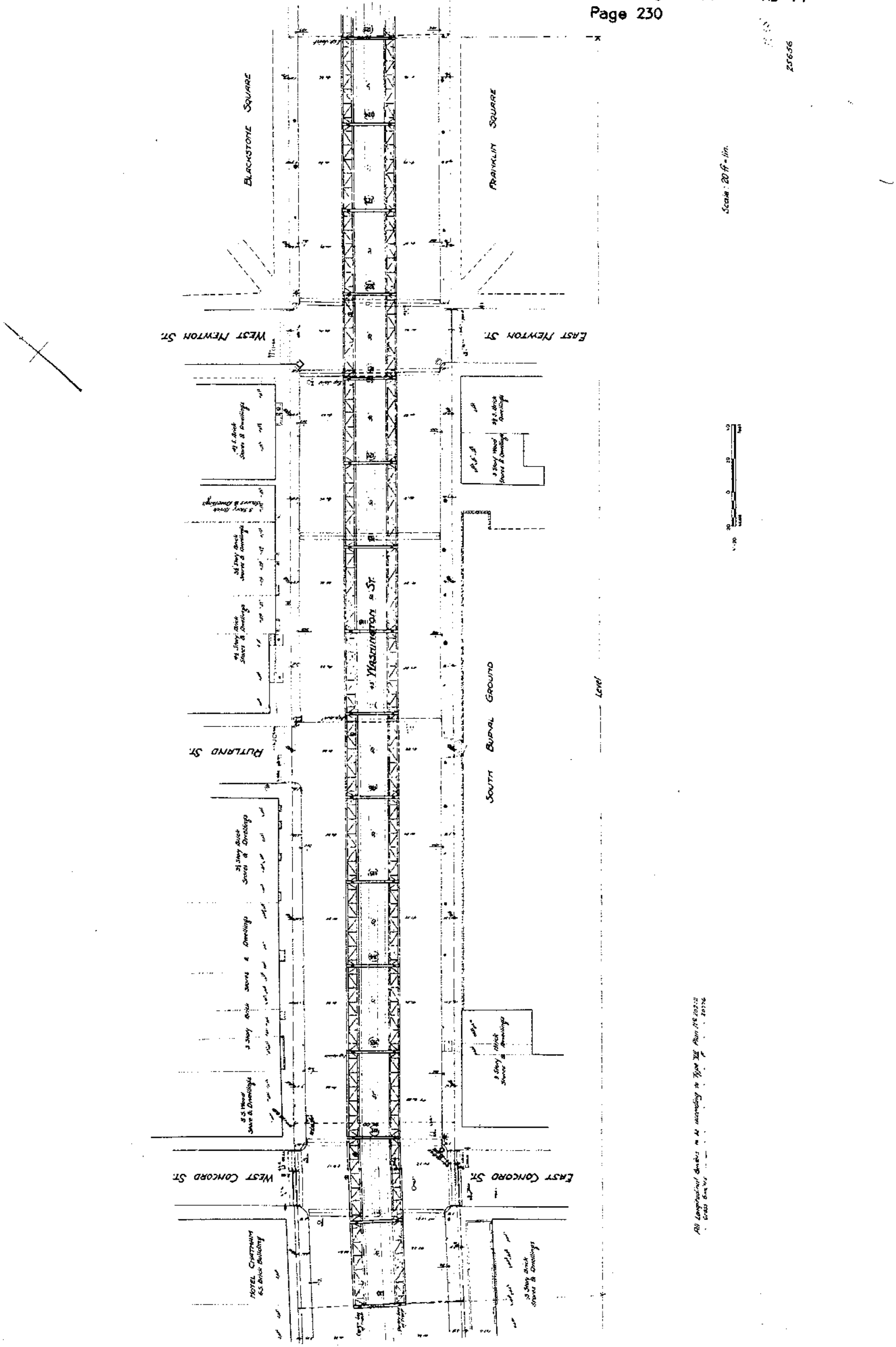
All longitudinals trusses are to be 5'-0¼" deep at centre of cross girders: bottom chord to be cambered as per details
Lateral bracing in plane of top chord only except where shown by dotted lines
Longitudinals to be according to Type VII sheet No 20272
Cross Girders to be according to Type F sheet No 20276

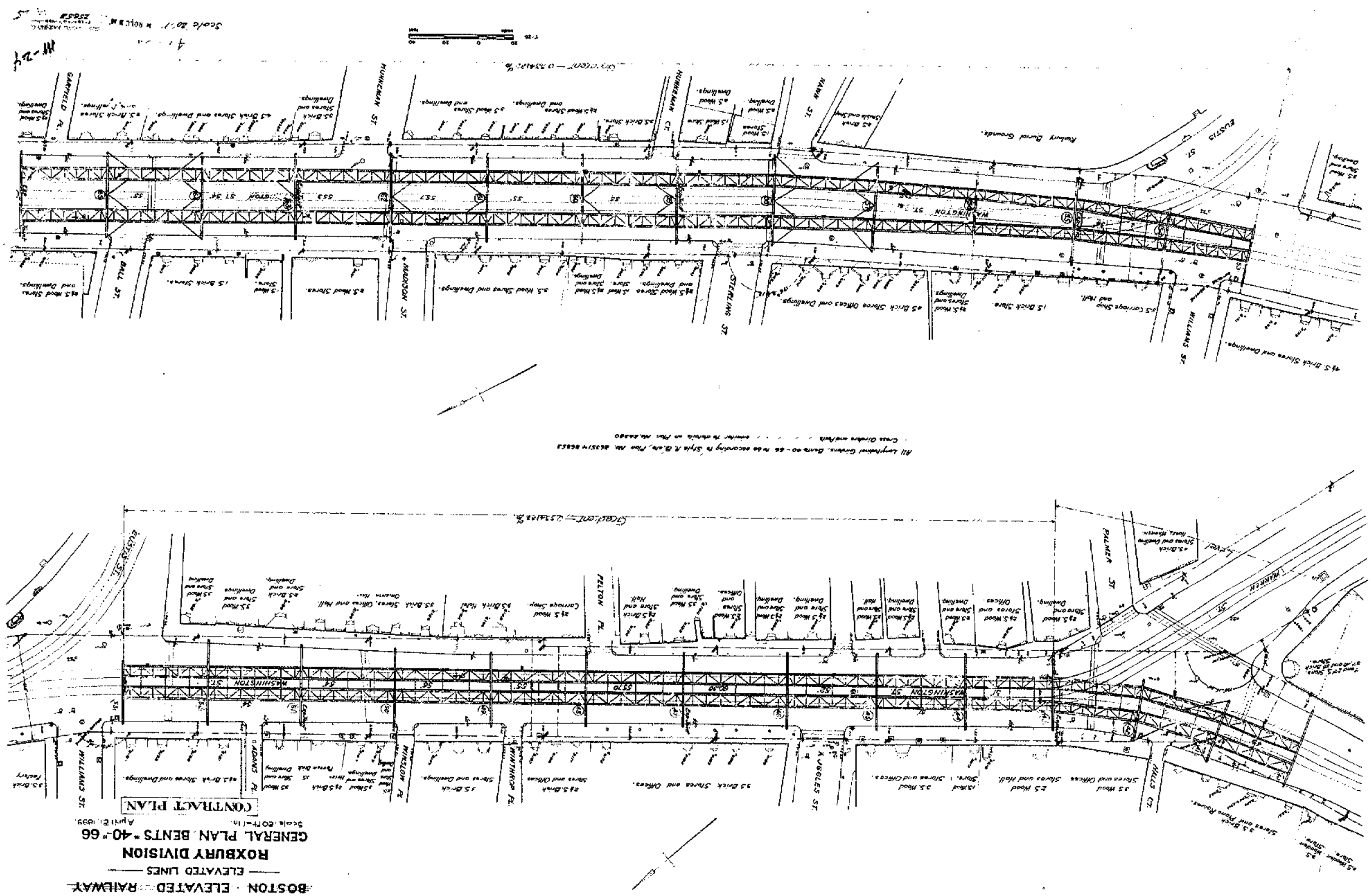
MATERIAL IN BENTS 112-120





M24
25676


Blackstone Square
Franklin Square
West Newton St.
East Newton St.
Washington St.
Rutland St.
South Burial Ground
West Concord St.
East Concord St.
Hotel Chatham
Level
Scale: 20 ft.=1 in.
25656


BOSTON ELEVATED RAILWAY
ELEVATED LINES
ROXBURY DIVISION
GENERAL PLAN BENTS 40-66
April 21, 1899.
CONTRACT PLAN
WASHINGTON ST.
EUSTIS ST.
WILLIAMS ST.
ADAMS PL.
WINSLOW PL.
WINTHROP PL.
FELTON PL.
RUGGLES ST.
PALMER ST.
WARREN ST.
HILLS CT.
GARFIELD PL.
BALL ST.
HUNNEMAN ST.
MADISON ST.
HUNNEMAN CT.
STERLING ST.
DAWN ST.
Roxbury Burial Grounds.

STEELWORK No. 1
Dec 21, 1897.

BOSTON ELEVATED RAILWAY.

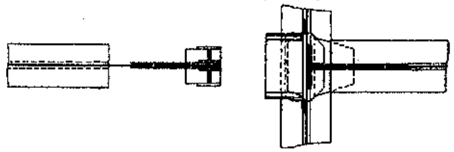
TYPICAL LONGITUDINAL GIRDER.

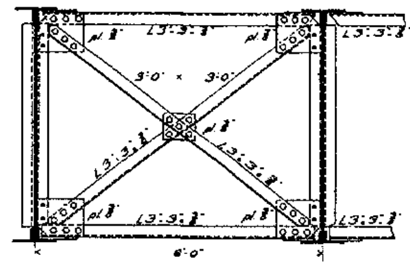
12 PANELS.

Geo. A. Kimball
Civil Eng.

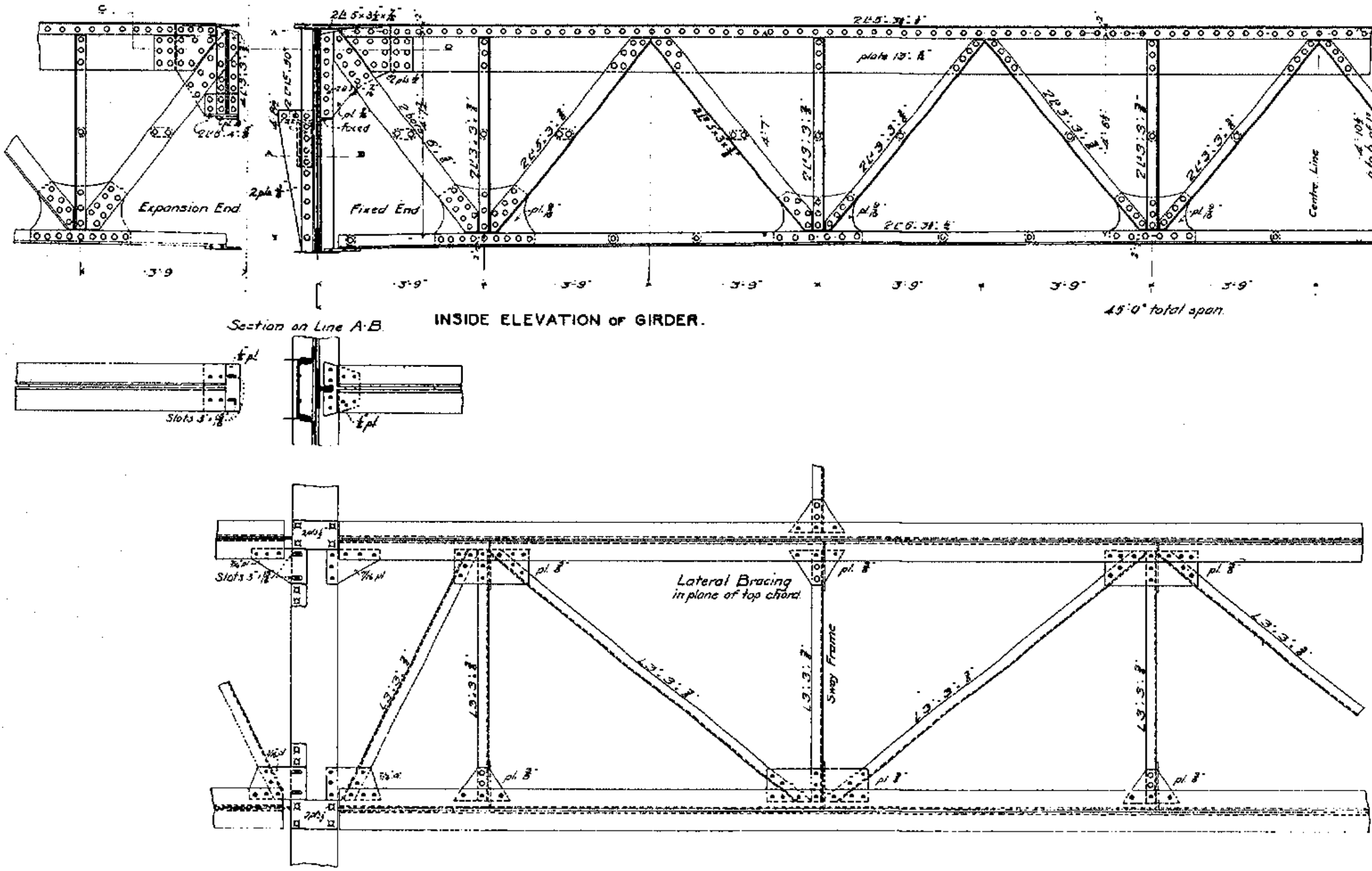
Scale ⅜ inch - 1 foot   RIVETS ⅞" DIA.

Section on Line C-D.





SWAY FRAME.



INSIDE ELEVATION OF GIRDER.

45'·0" total span.

Abstract of Specifications

Material Medium Steel

Live Load

Longitudinal force at level of rails equal to ⅒ of live load over whole span. Transverse load, acting at top of posts, equal to 450 lbs. per lineal foot of span.

Unit Strains

Tension per sq. in. of net section.
In longitudinal girders and trusses 10000 lbs
In transverse girders, except where maximum strains are produced from a single truck load. 12000
In lateral bracing 15000

Compression per sq. in. of section.
Compression flanges of plate girders same area as tension.

In longitudinal trusses $\dfrac{8000}{1+\dfrac{l^2}{36000r^2}}$

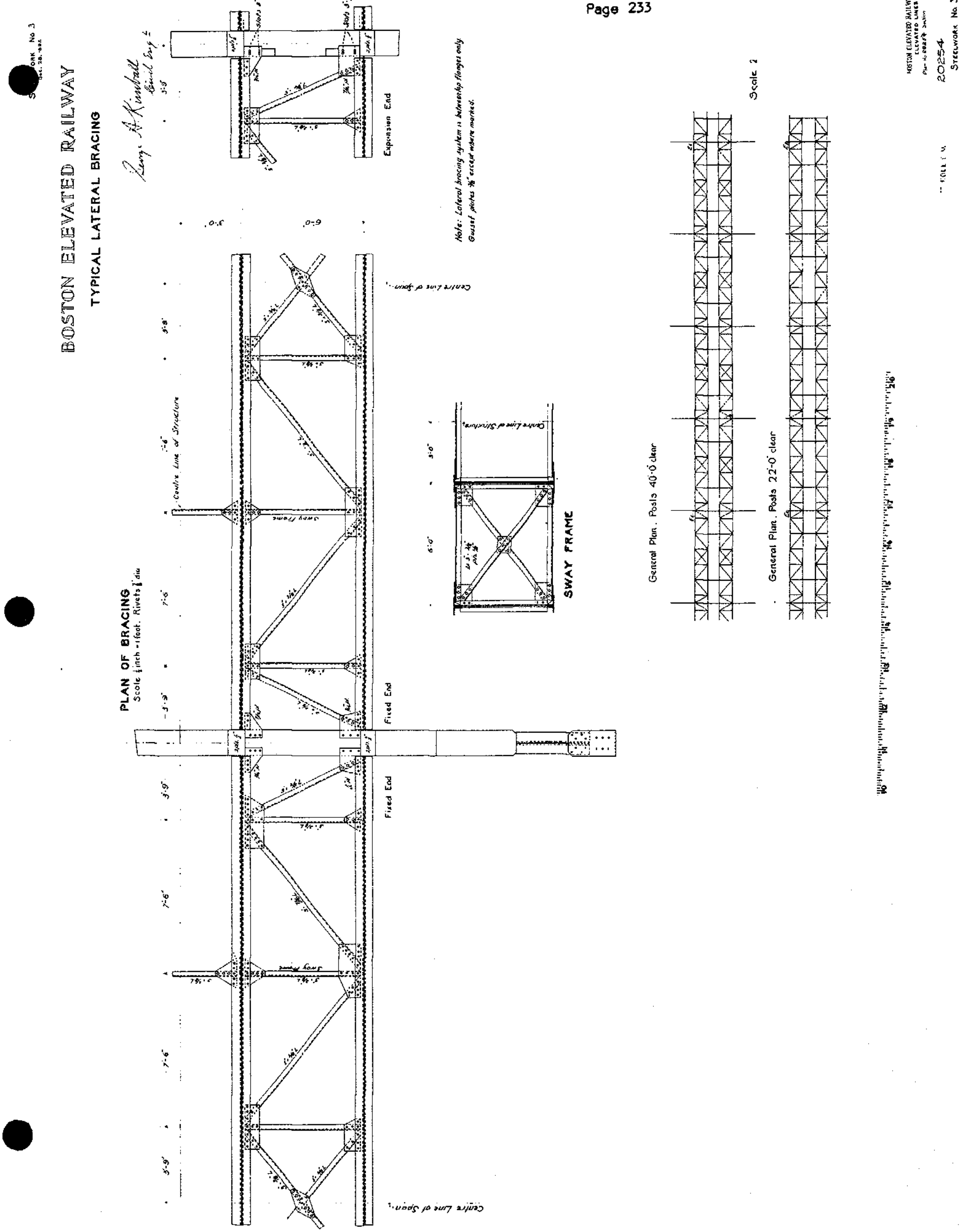
In posts $\dfrac{10000}{1+\dfrac{l^2}{36000r^2}}$

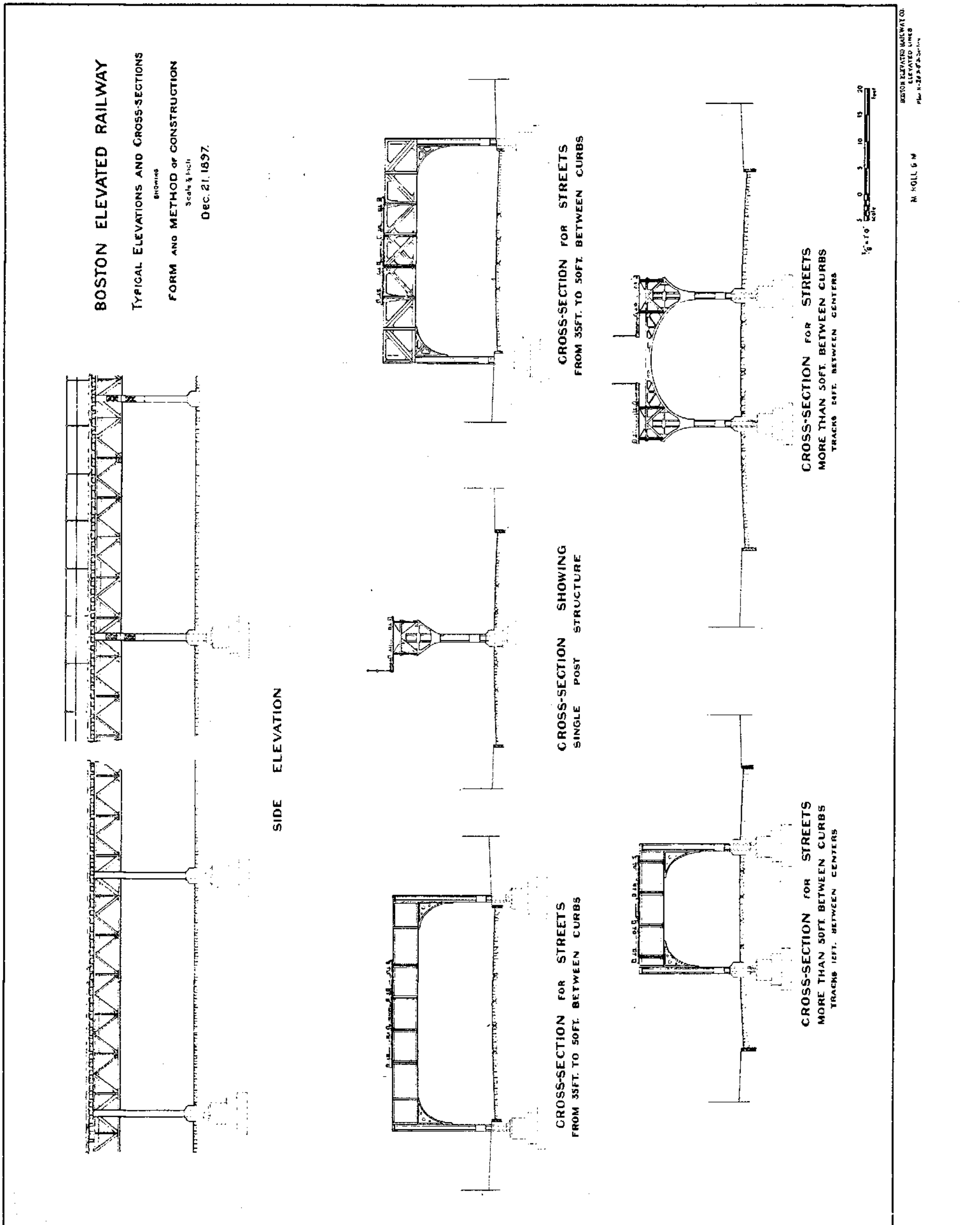
Combined fibre strains from bending and axial strains, per sq. in.
In top chords of longitudinal girders, 10000 lbs.
In posts, from horizontal and vertical forces, 20000 "

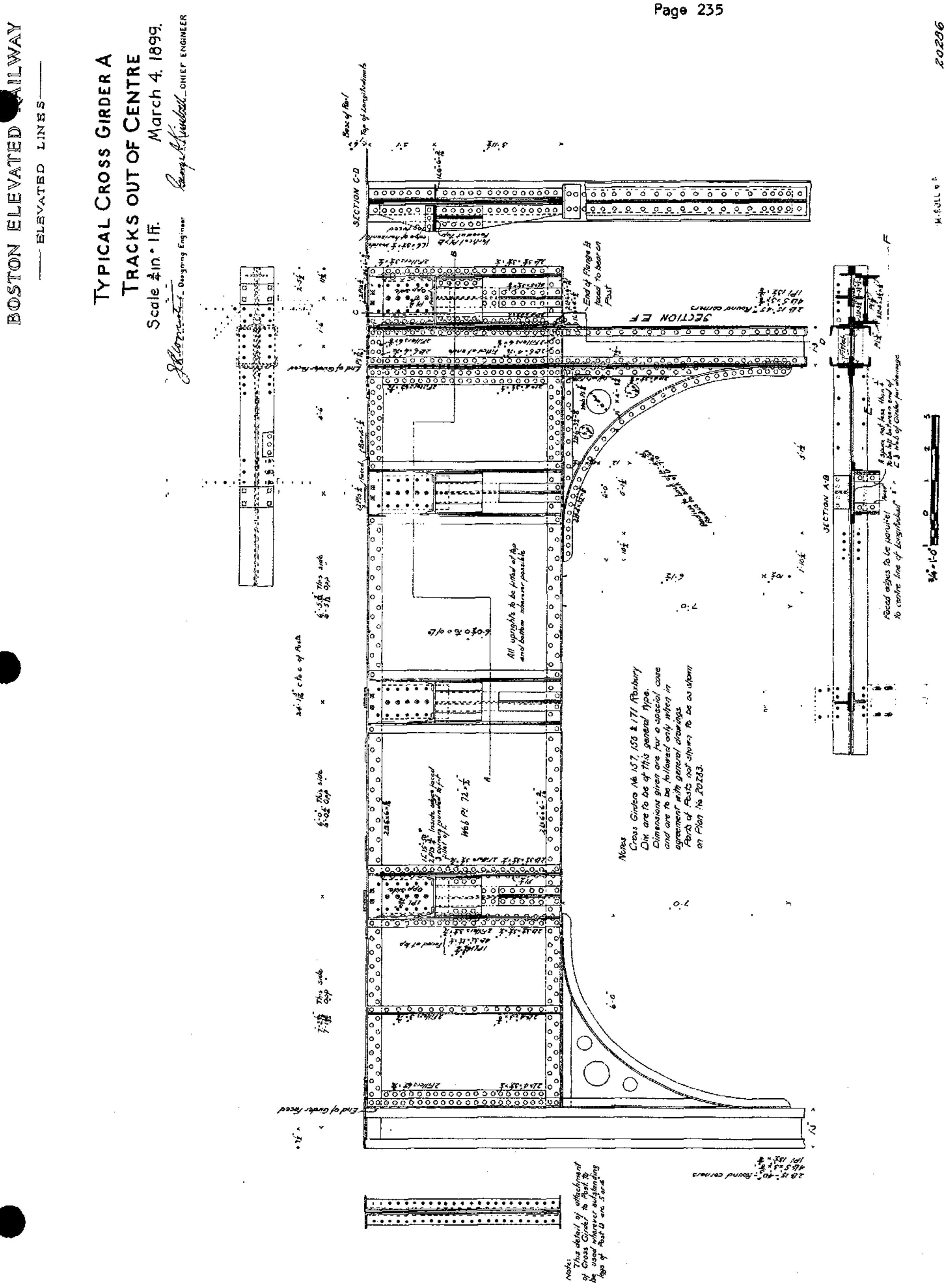
Strain on Rivets per sq. in.

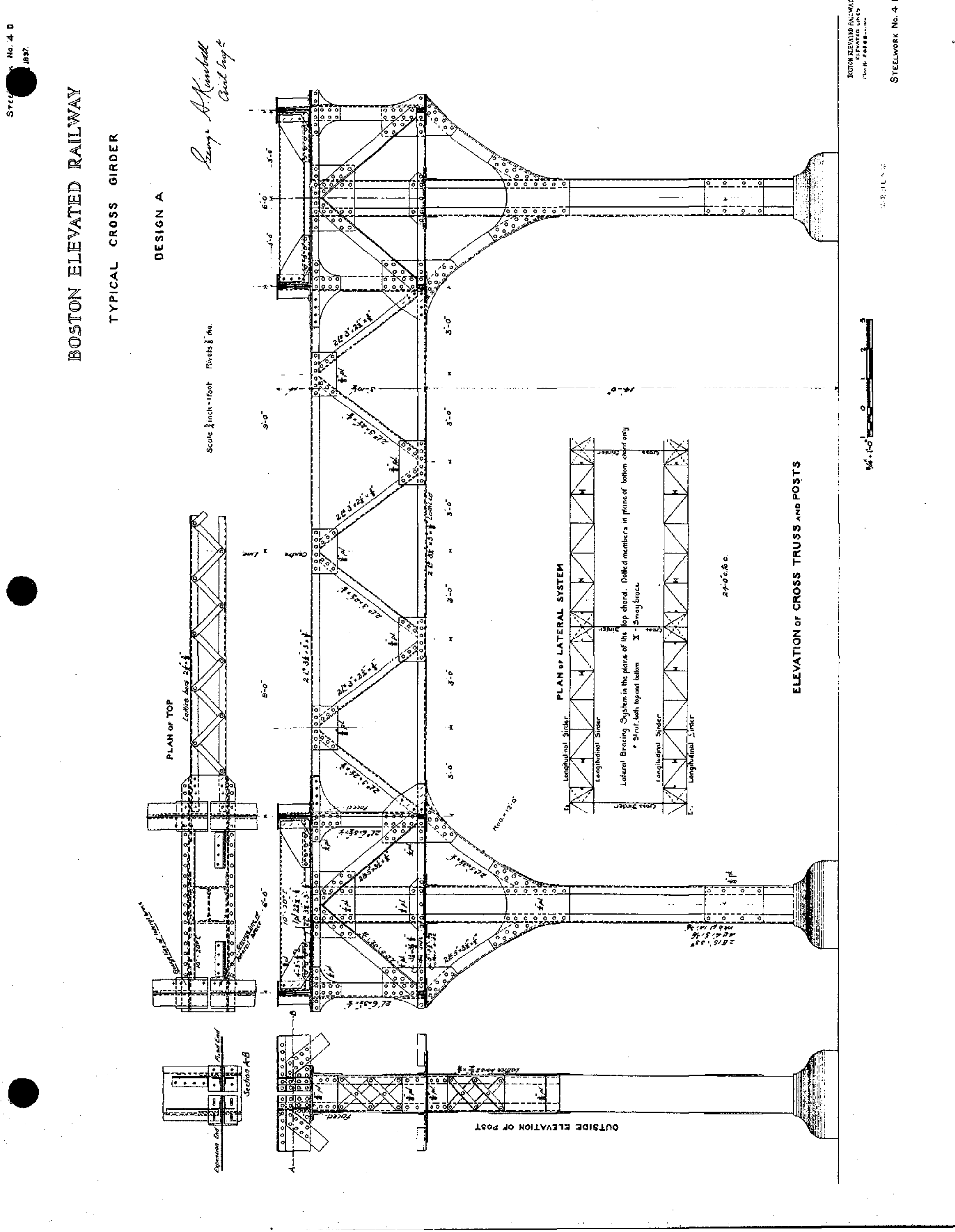
		Enclosed Metal	Unenclosed Metal
Machine driven	Shear	9000	9000
	Bearing	18000	12000
Hand driven	Shear	7500	7500
	Bearing	12500	10000

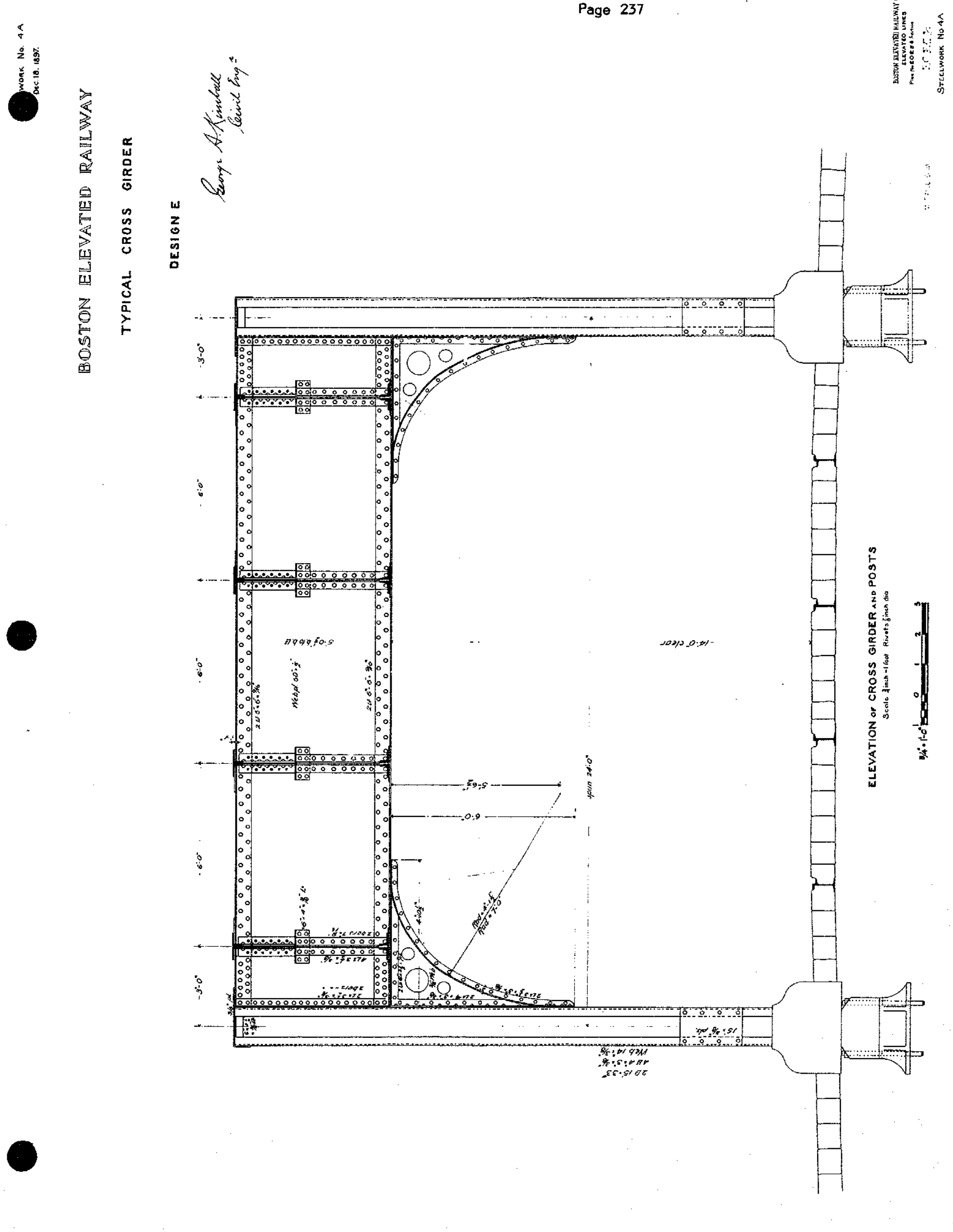
STEELWORK No. 1
Dec 21, 1897.


BOSTON ELEVATED RAILWAY
TYPICAL LATERAL BRACING
PLAN OF BRACING
Expansion End
Fixed End
Fixed End
Centre Line of Span
Centre Line of Span
Centre Line of Structure
Sway Frame
Sway Frame
Centre Line of Structure
SWAY FRAME
Note: Lateral bracing system is between top flanges only.
General Plan. Posts 40'-0" clear
General Plan. Posts 22'-0" clear
Scale 2
20254
Steelwork No. 3

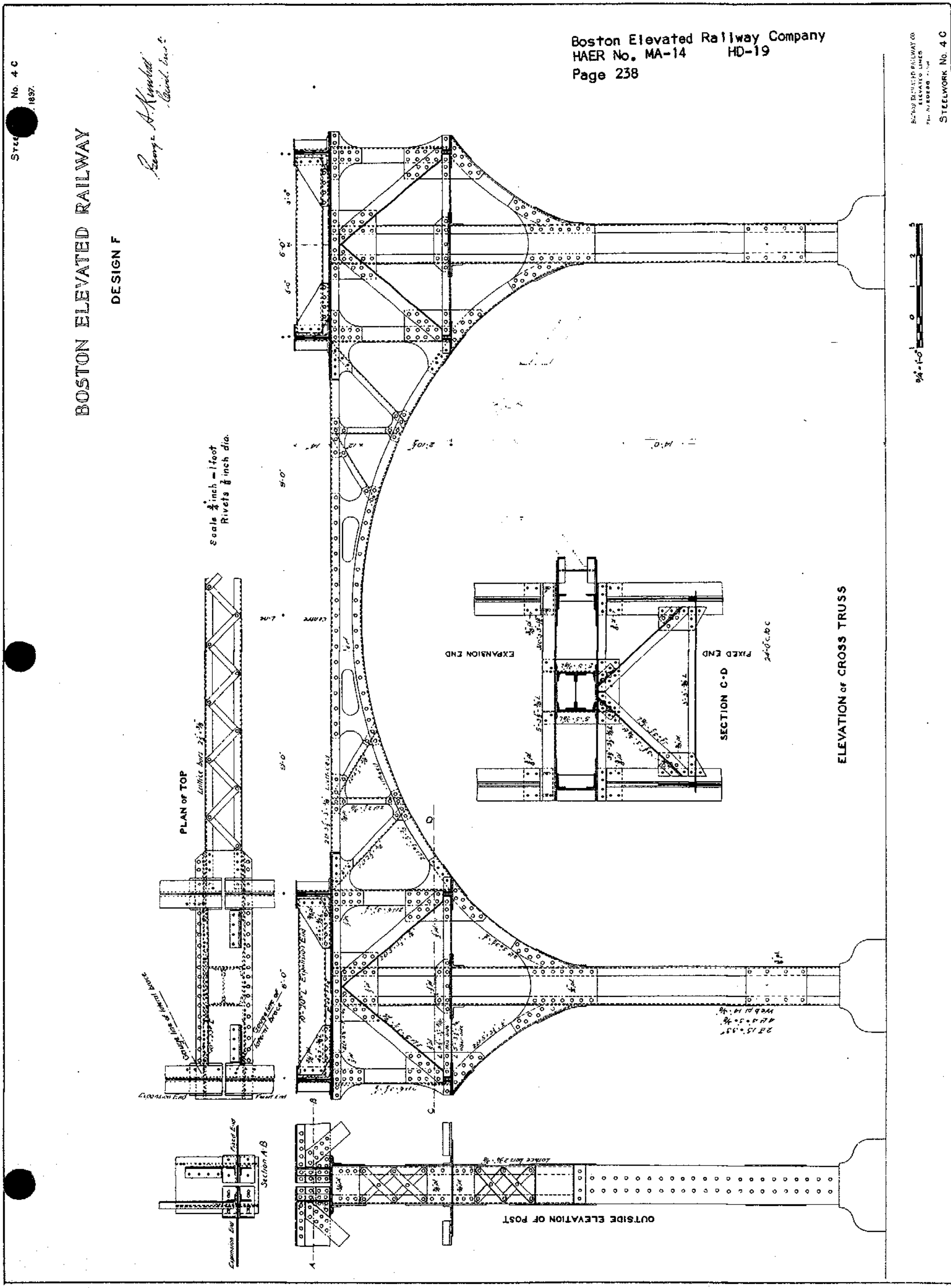

BOSTON ELEVATED RAILWAY
TYPICAL ELEVATIONS AND CROSS-SECTIONS
SHOWING
FORM AND METHOD OF CONSTRUCTION
Dec. 21. 1897.
SIDE ELEVATION
CROSS-SECTION FOR STREETS
FROM 35FT. TO 50FT. BETWEEN CURBS
CROSS-SECTION SHOWING
SINGLE POST STRUCTURE
CROSS-SECTION FOR STREETS
FROM 35FT. TO 50FT. BETWEEN CURBS
CROSS-SECTION FOR STREETS
MORE THAN 50FT. BETWEEN CURBS
TRACKS 24FT. BETWEEN CENTERS
CROSS-SECTION FOR STREETS
MORE THAN 50FT. BETWEEN CURBS
TRACKS 16FT. BETWEEN CENTERS

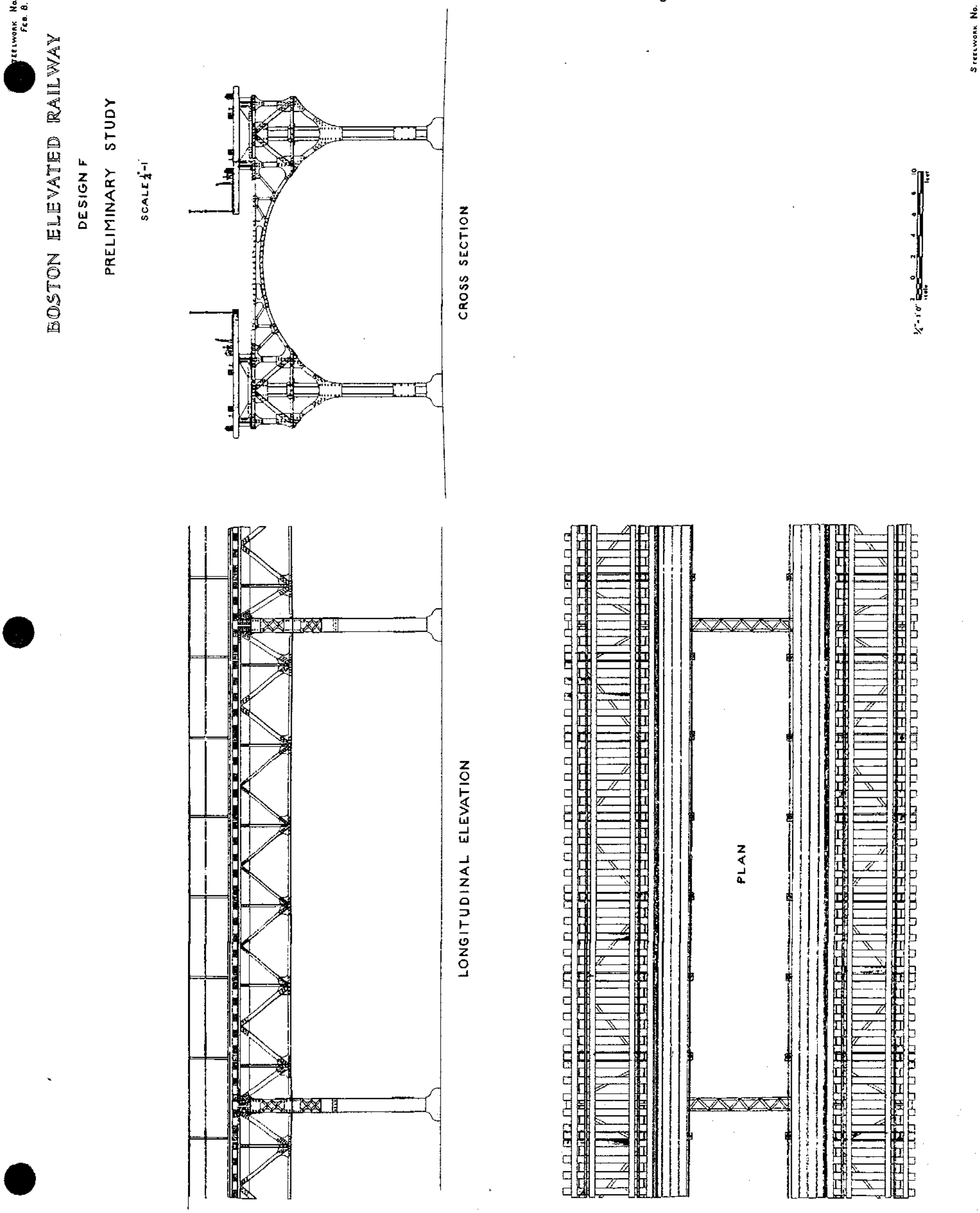

BOSTON ELEVATED RAILWAY
ELEVATED LINES
TYPICAL CROSS GIRDER A
TRACKS OUT OF CENTRE
Scale 1/4 in = 1 ft.
March 4. 1899.
Designing Engineer
CHIEF ENGINEER
20286
SECTION C-D
SECTION E F
SECTION A-B
All uprights to be fitted at top and bottom wherever possible
Notes
Cross Girders No. 157, 158 & 171 Roxbury Div. are to be of this general type.
Dimensions given are for a special case and are to be followed only when in agreement with general drawings.
Parts of Posts not shown to be as shown on Plan No. 20283.
End of Girder faced
Faced edges to be parallel to centre line of Longitudinal
Note: This detail of attachment of Cross Girder to Post to be used wherever outstanding legs of Post L are 5 or 4

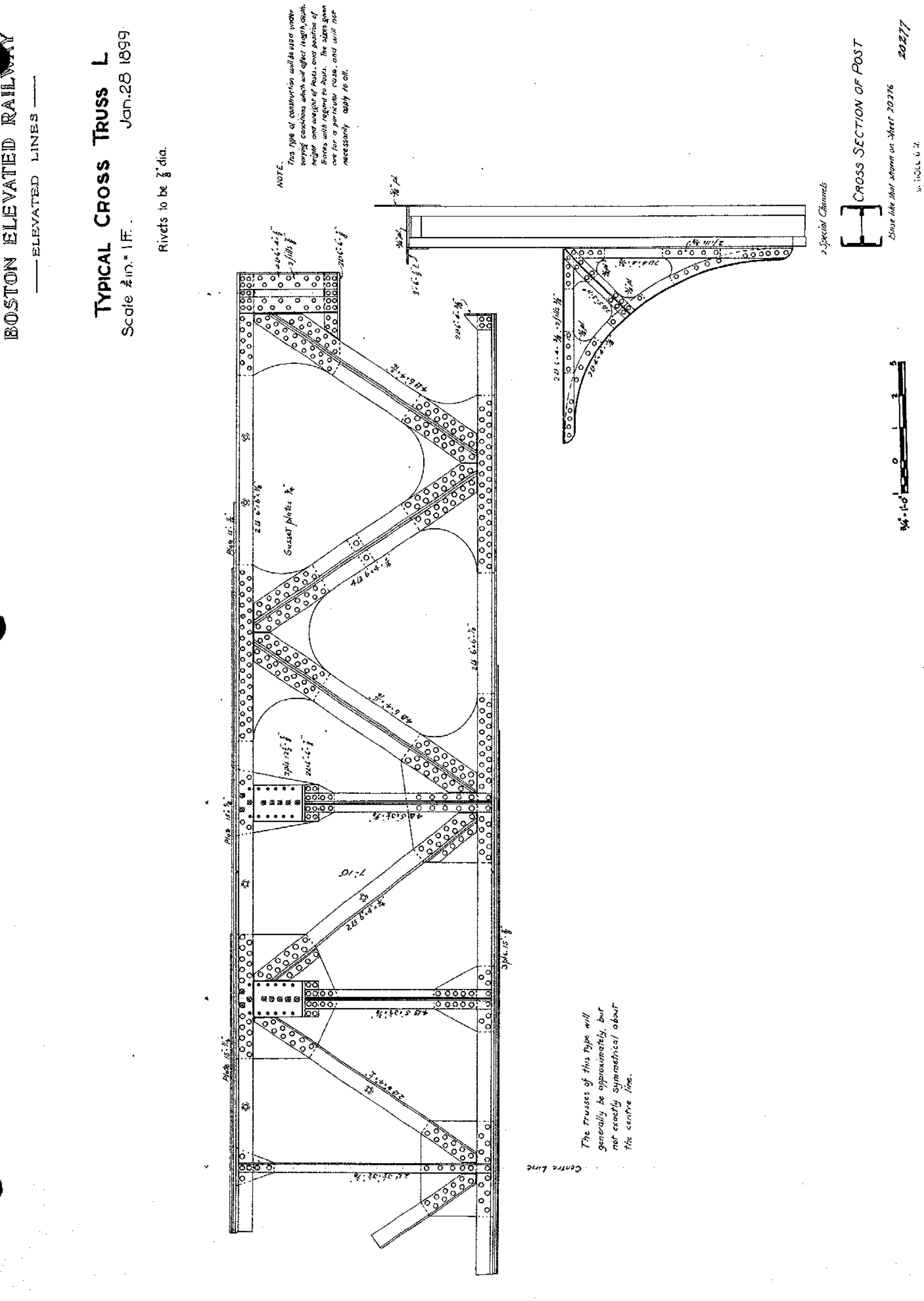

BOSTON ELEVATED RAILWAY
TYPICAL CROSS GIRDER
DESIGN A
Scale ¾ inch = 1 foot Rivets ⅞" dia.
ELEVATION OF CROSS TRUSS AND POSTS
PLAN OF LATERAL SYSTEM
Lateral Bracing System in the plane of the top chord. Dotted members in plane of bottom chord only
Strut, both top and bottom
Sway brace
Longitudinal Girder
Cross Girder
PLAN OF TOP
OUTSIDE ELEVATION OF POST
Section A-B
Expansion End
Fixed End
STEELWORK No. 4 D

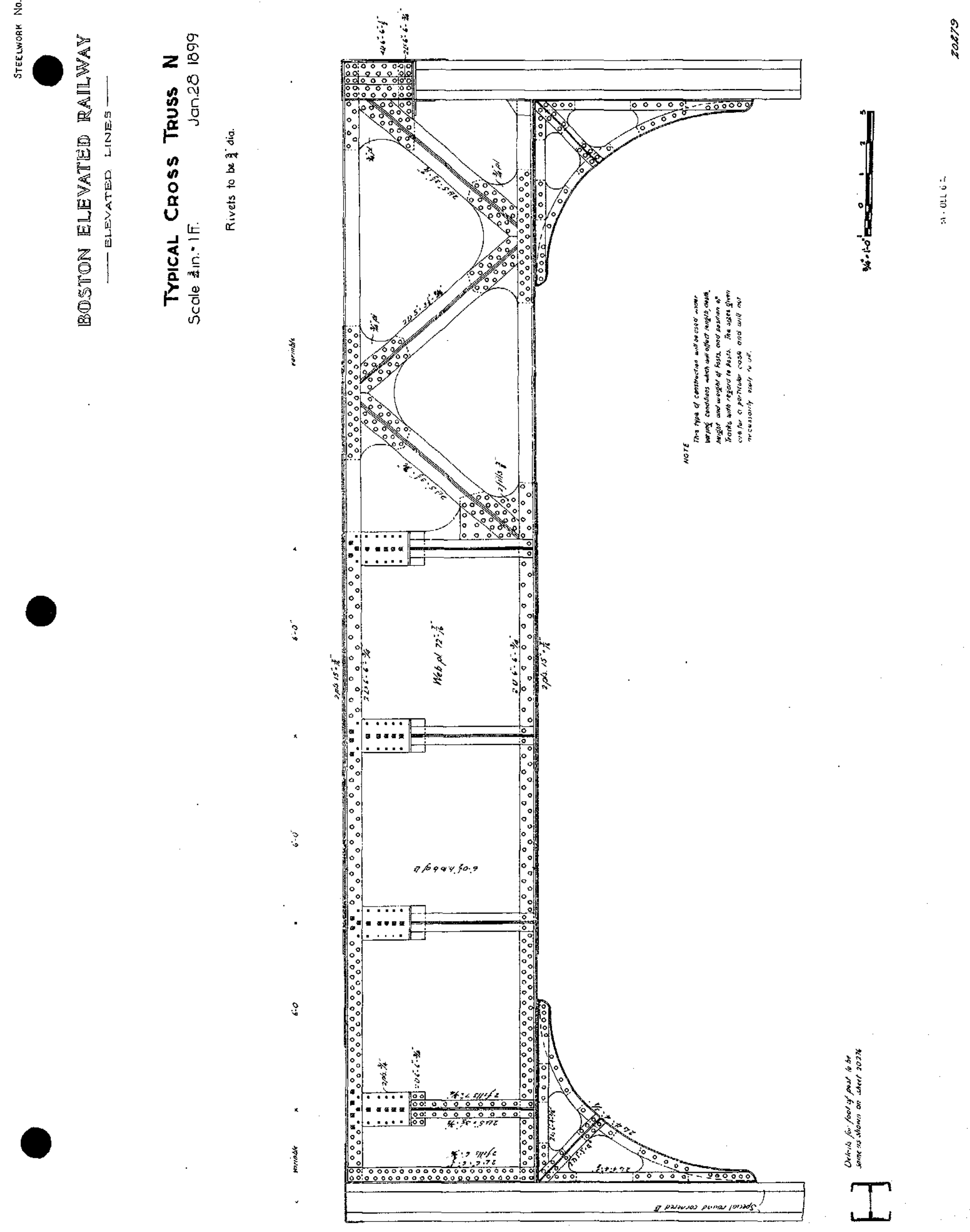

WORK No. 4A
Dec. 18. 1897.
BOSTON ELEVATED RAILWAY
TYPICAL CROSS GIRDER
DESIGN E
Geo. A. Kimball
Civil Eng.
STEELWORK No 4A
3'-0"
6'-0"
6'-0"
6'-0"
3'-0"
-14'-0" clear
span 24'-0"
ELEVATION OF CROSS GIRDER AND POSTS
Scale 3/4 inch = 1 foot Rivets 7/8 inch dia

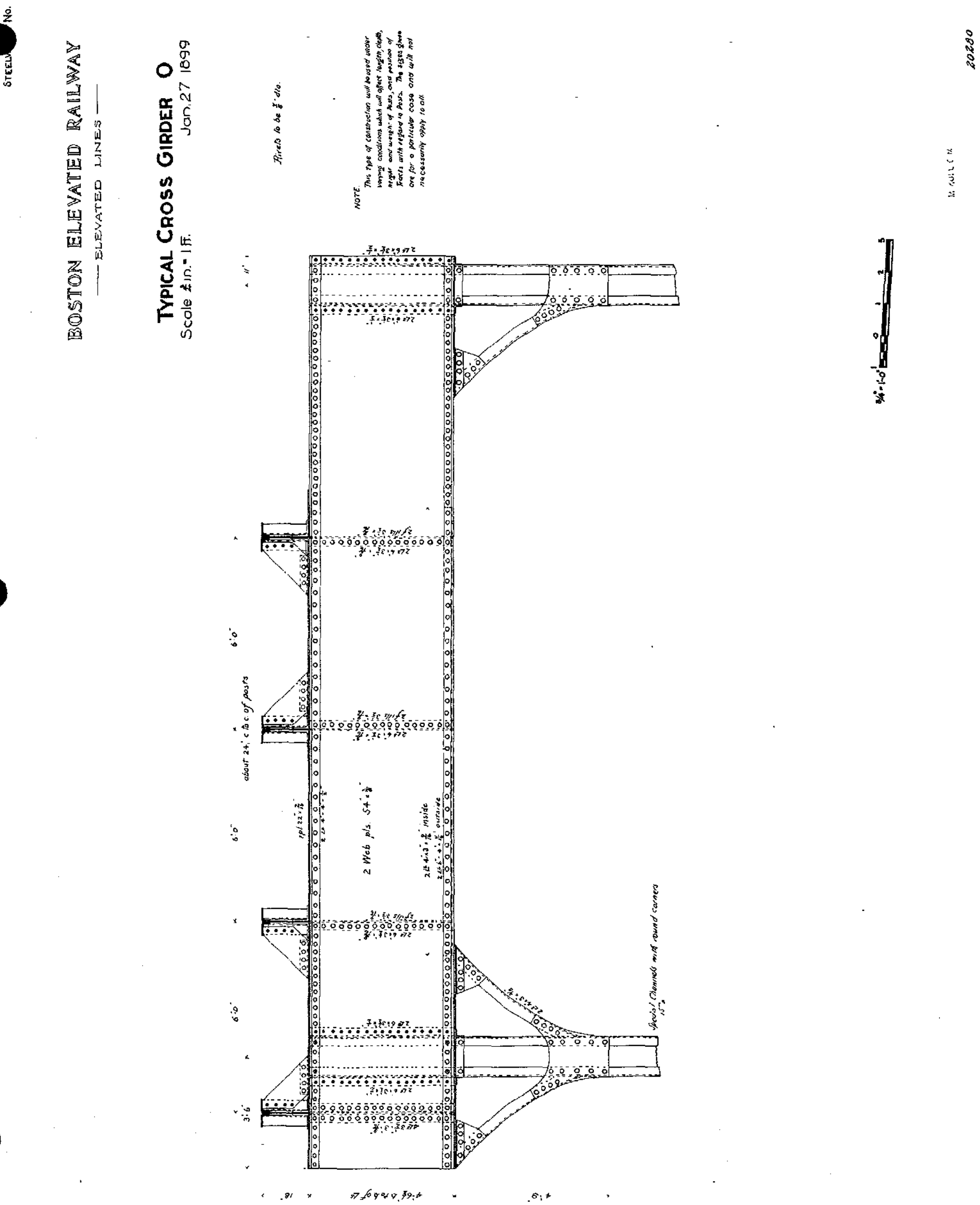
Boston Elevated Railway Company
HAER No. MA-14 HD-19
Page 238

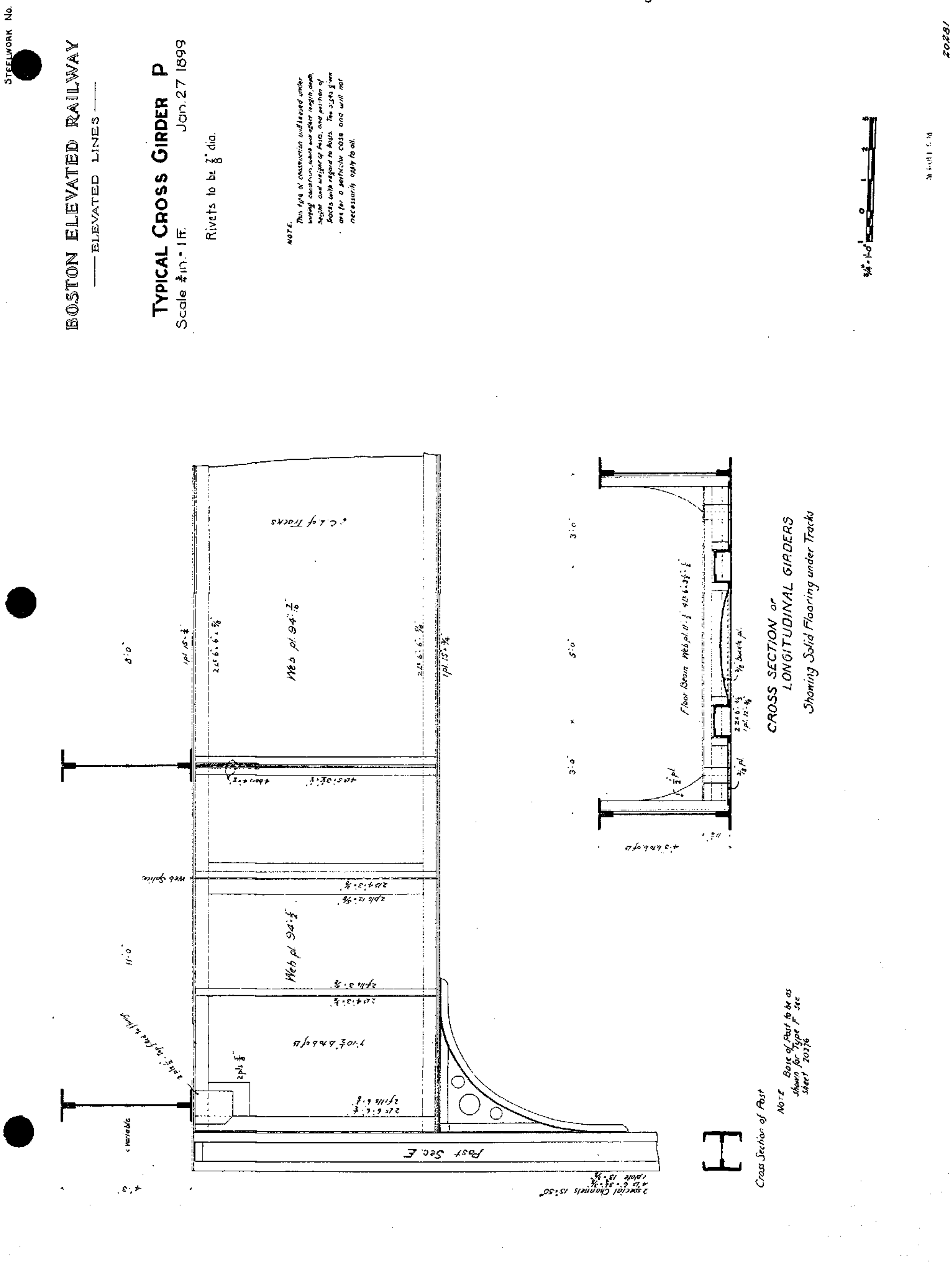


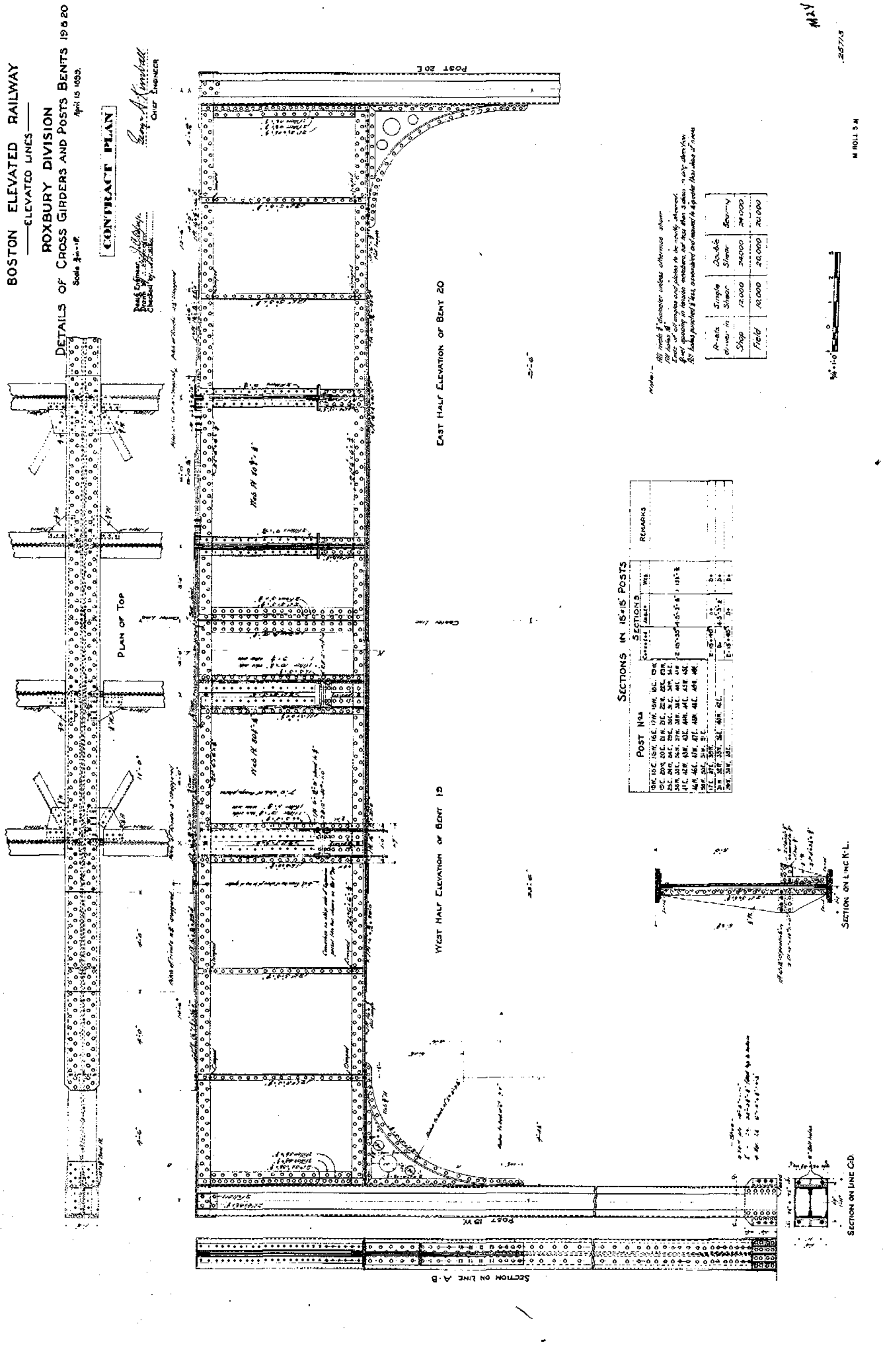

STEELWORK No. 6. FEB. 8. 1898.
BOSTON ELEVATED RAILWAY
DESIGN F
PRELIMINARY STUDY
SCALE ¼"-1'
CROSS SECTION
LONGITUDINAL ELEVATION
PLAN
STEELWORK No. 6.

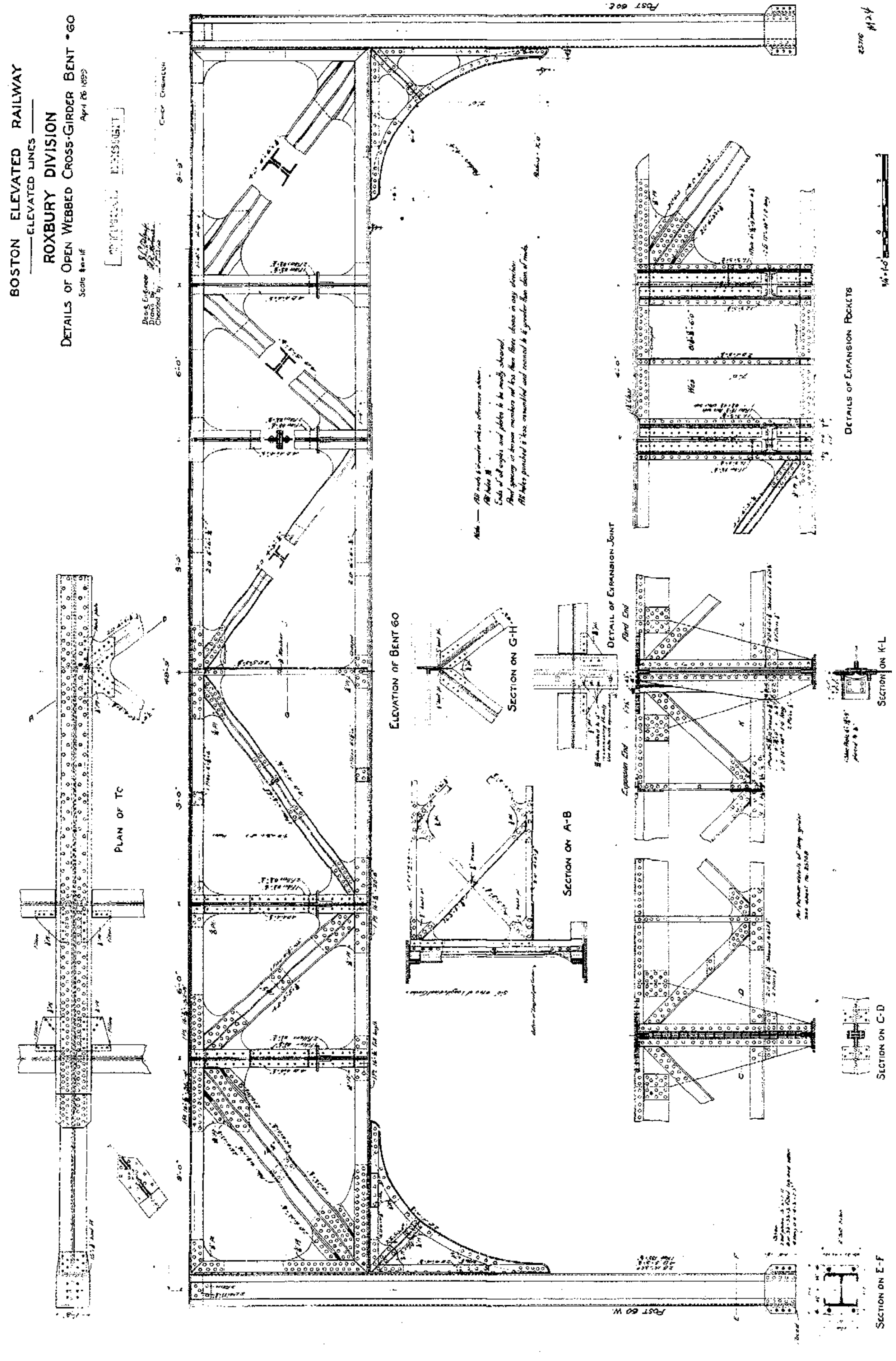

BOSTON ELEVATED RAILWAY
ELEVATED LINES
TYPICAL CROSS TRUSS L
Scale ¾ in. = 1 Ft.
Jan. 28 1899
Rivets to be ⅞" dia.
NOTE.
This type of construction will be used under varying conditions which will affect length, depth, height and weight of Posts, and position of Braces with regard to Posts. The sizes given are for a particular case, and will not necessarily apply to all.
Gusset plates ¾"
CROSS SECTION OF POST
Special Channels
Base like that shown on sheet 20276
20277
The trusses of this type will generally be approximately, but not exactly symmetrical about the centre line.
Centre Line

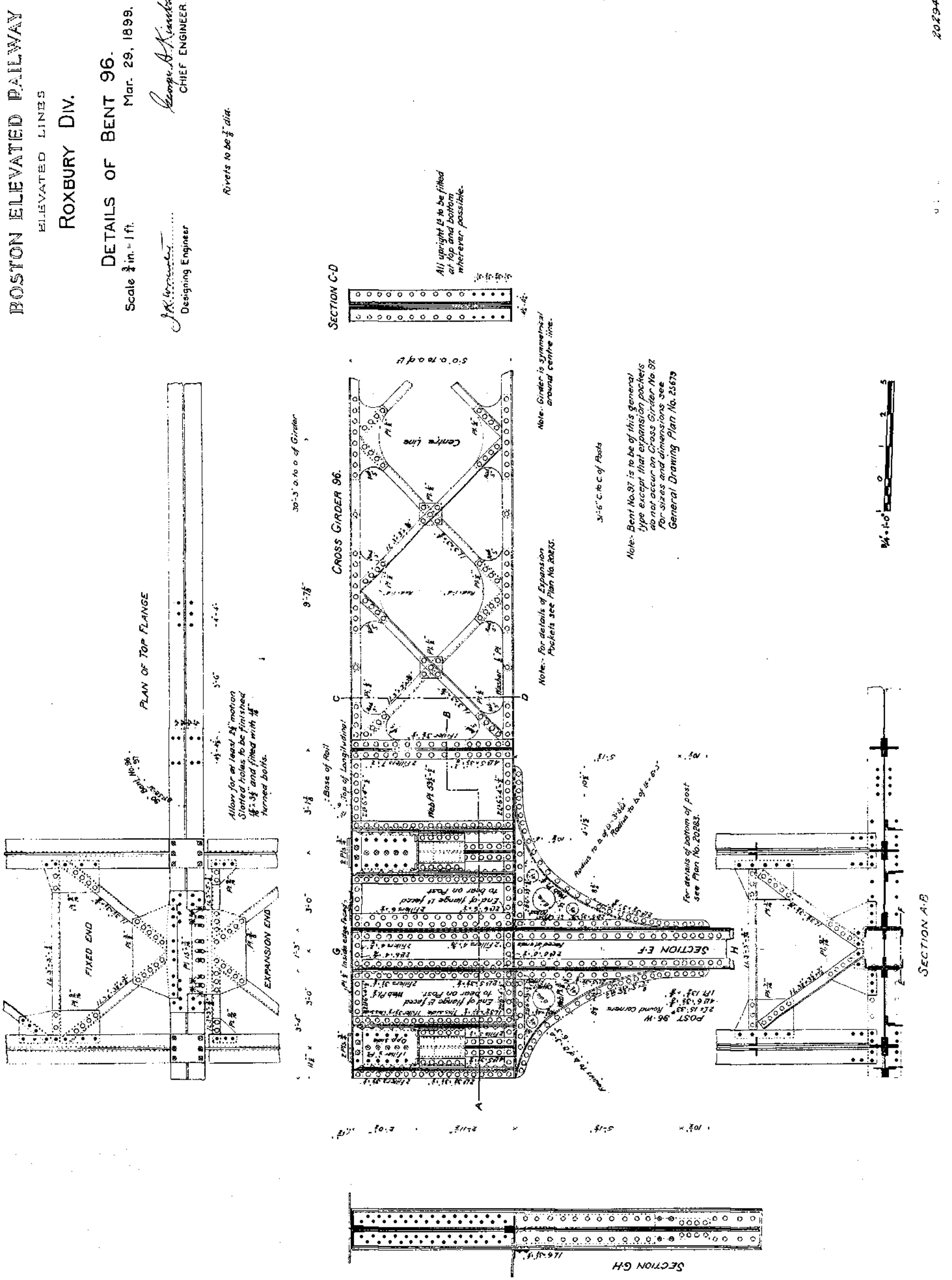

Steelwork No.
BOSTON ELEVATED RAILWAY
ELEVATED LINES
TYPICAL CROSS TRUSS N
Scale 3/4 in. = 1 Ft.
Jan. 28 1899
Rivets to be 3/4" dia.
Web pl 72" x 7/16
20879

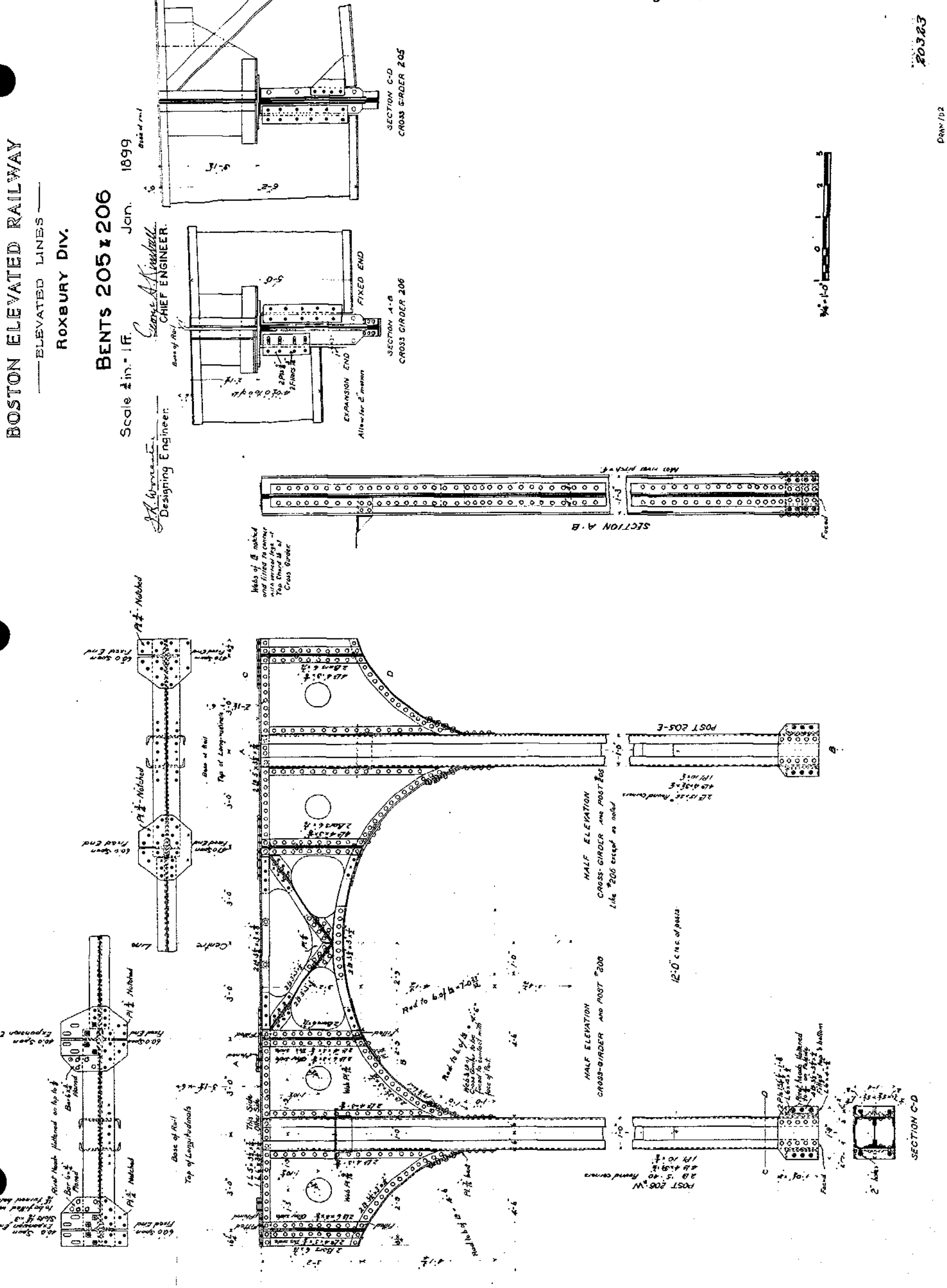

STEEL No.
BOSTON ELEVATED RAILWAY
— ELEVATED LINES —
TYPICAL CROSS GIRDER O
Scale ½ in.= 1 ft.
Jan. 27 1899
Rivets to be ⅞" dia.
NOTE.
This type of construction will be used under varying conditions which will affect length, depth, height and weight of Posts, and position of Tracks with regard to Posts. The sizes given are for a particular case and will not necessarily apply to all.
about 24' c. to c. of posts
6'0"
6'0"
6'0"
3'6"
2 Web pls. 54 × ⅜
Special Channels with round corners
20280

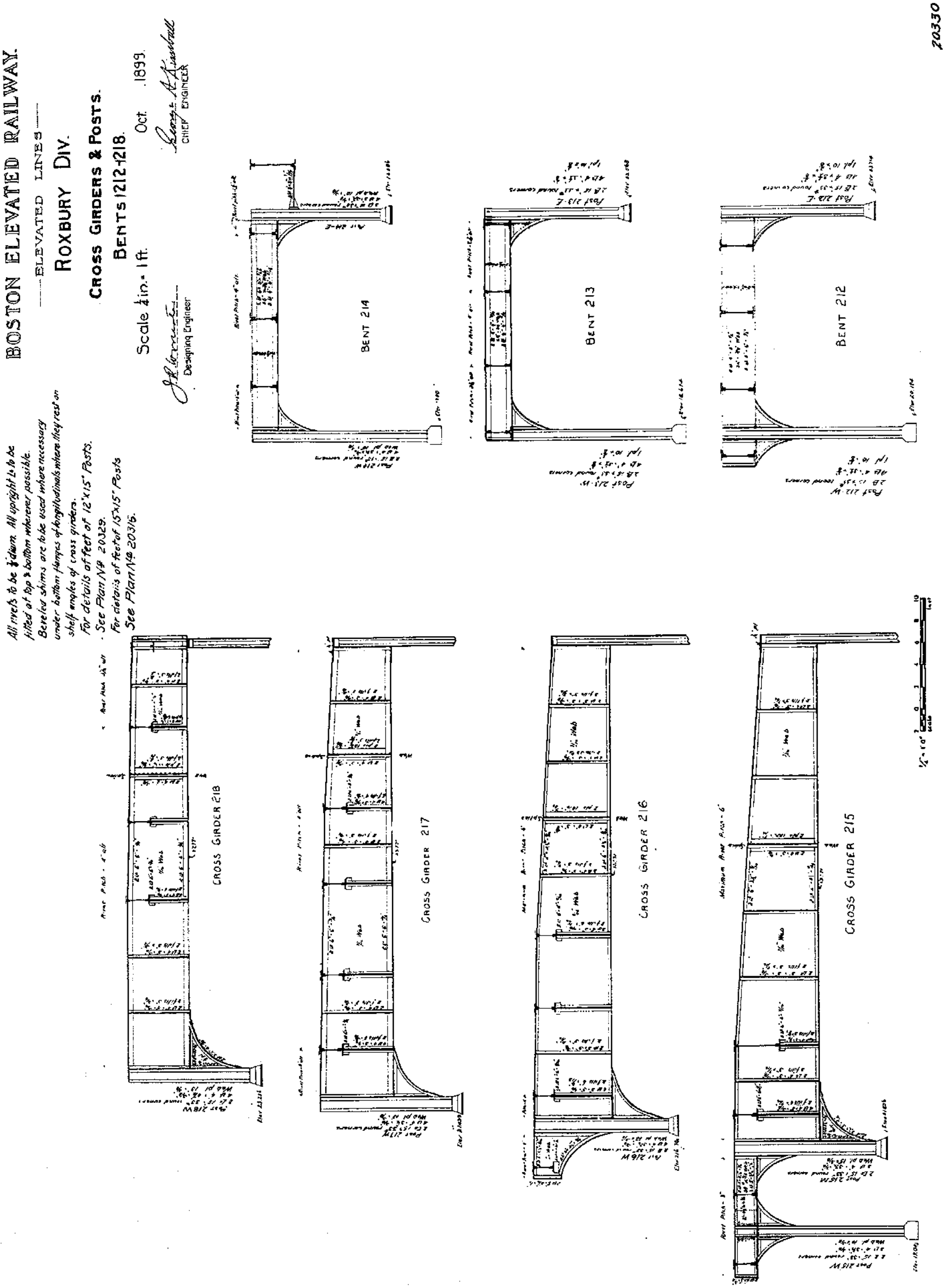

STEELWORK No.
BOSTON ELEVATED RAILWAY
ELEVATED LINES
TYPICAL CROSS GIRDER P
Scale ¾ in. = 1 ft. Jan. 27 1899
Rivets to be ⅞" dia.
NOTE.
This type of construction will be used under various conditions which will affect length, depth, height and weight of posts, and position of tracks with regard to posts. The sizes given are for a particular case and will not necessarily apply to all.
C. L. of Tracks
Web pl. 94 · 7/16
Web pl. 94 · ½
Web Splice
Post Sec. E
Cross Section of Post
NOTE Base of Post to be as shown for Type F see Sheet 20276
CROSS SECTION OF LONGITUDINAL GIRDERS
Showing Solid Flooring under Tracks
Floor Beam
20281

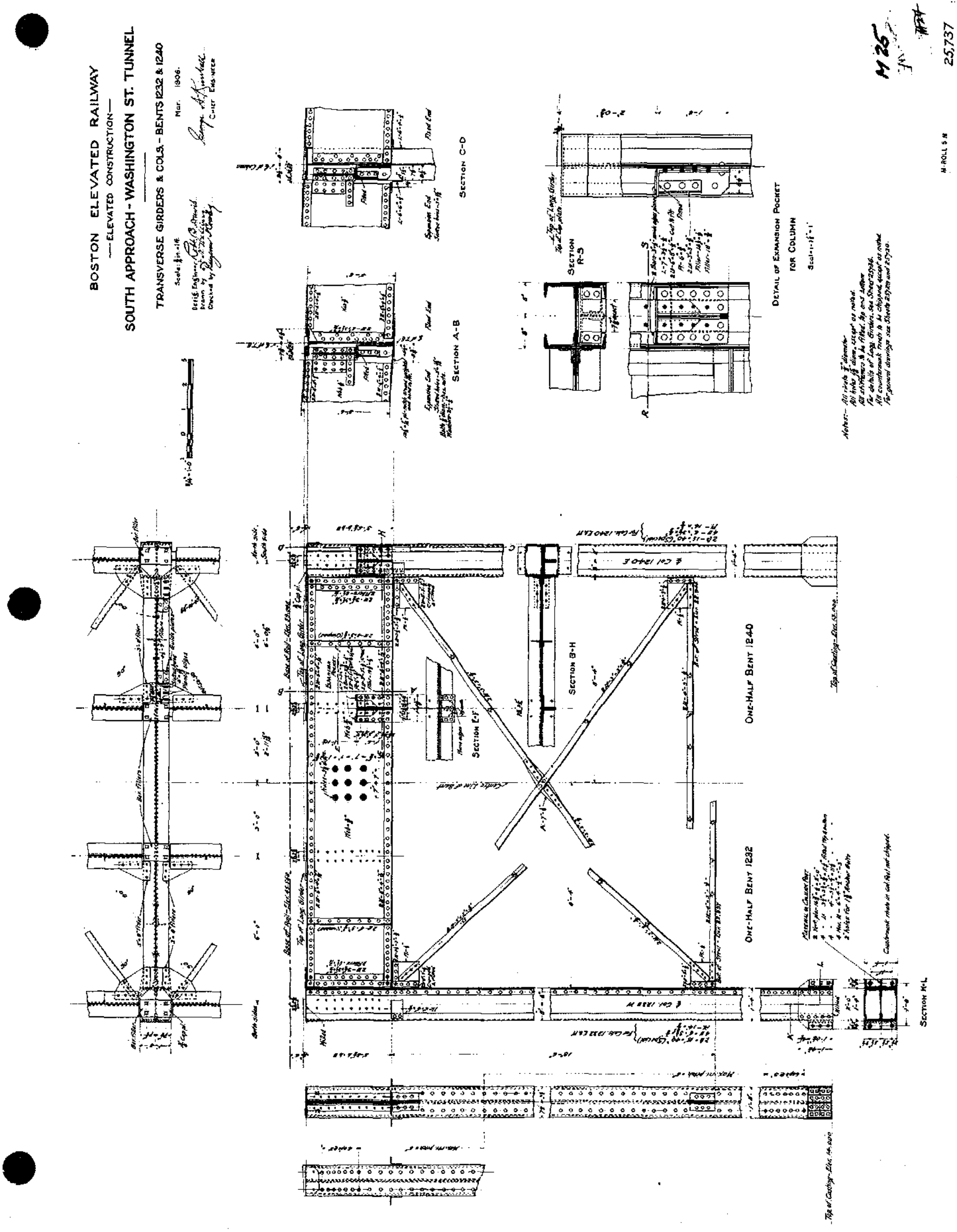

BOSTON ELEVATED RAILWAY
ELEVATED LINES
ROXBURY DIVISION
DETAILS OF CROSS GIRDERS AND POSTS BENTS 19 & 20
CONTRACT PLAN
PLAN OF TOP
EAST HALF ELEVATION OF BENT 20
WEST HALF ELEVATION OF BENT 19
POST 20 E
POST 19 W
SECTIONS IN 15"x15" POSTS
SECTION ON LINE A-B
SECTION ON LINE C-D
SECTION ON LINE K-L

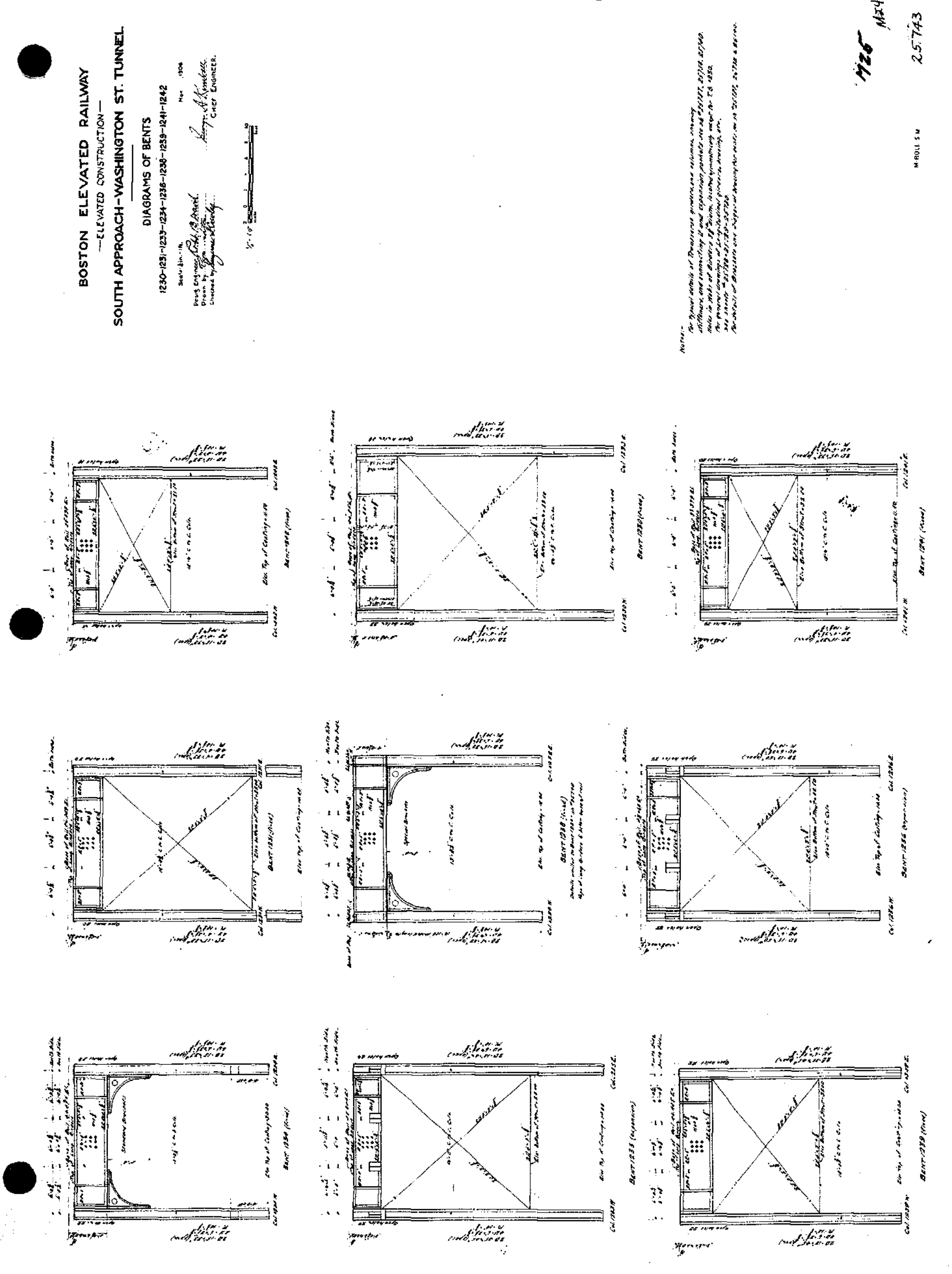

BOSTON ELEVATED RAILWAY
ELEVATED LINES
ROXBURY DIVISION
DETAILS OF OPEN WEBBED CROSS-GIRDER BENT #60
April 26 1899
ELEVATION OF BENT 60
SECTION ON G-H
DETAIL OF EXPANSION JOINT
Fixed End
Expansion End
SECTION ON K-L
SECTION ON A-B
SECTION ON C-D
SECTION ON E-F
PLAN OF Tc
DETAILS OF EXPANSION POCKETS
POST 60 E.
POST 60 W.


BOSTON ELEVATED RAILWAY
ELEVATED LINES
ROXBURY DIV.
DETAILS OF BENT 96.
Scale ¾ in. = 1 ft.
Mar. 29, 1899.
Designing Engineer
CHIEF ENGINEER
Rivets to be ⅞" dia.
20294
PLAN OF TOP FLANGE
FIXED END
EXPANSION END
Allow for at least 1¾" motion
CROSS GIRDER 96.
Centre Line
SECTION C-D
All upright Ls to be fitted at top and bottom wherever possible.
Note:- Girder is symmetrical around centre line.
Note:- For details of Expansion Pockets see Plan No. 20215.
Note:- Bent No. 97 is to be of this general type except that expansion pockets do not occur on Cross Girder No. 97. For sizes and dimensions see General Drawing Plan No. 25679
For details of bottom of post see Plan No. 20283.
SECTION E-F
POST 96-W
SECTION A-B
SECTION G-H


BOSTON ELEVATED RAILWAY
ELEVATED LINES
ROXBURY DIV.
BENTS 205 & 206
Scale ¼ in.= 1 ft.
Jan. 1899
CHIEF ENGINEER.
Designing Engineer.
SECTION C-D CROSS GIRDER 205
SECTION A-B CROSS GIRDER 206
FIXED END
EXPANSION END
SECTION A-B
HALF ELEVATION CROSS-GIRDER AND POST 205
HALF ELEVATION CROSS-GIRDER AND POST 200
POST 205-E
POST 206-W
SECTION C-D
12'-0" c. to c. of posts
203.23


BOSTON ELEVATED RAILWAY.
—ELEVATED LINES—
ROXBURY DIV.
CROSS GIRDERS & POSTS.
BENTS 212-218.
Scale ¼in.= 1ft.
Oct. 1899.
CHIEF ENGINEER
Designing Engineer
All rivets to be ⅞ diam. All upright Ls to be fitted at top & bottom wherever possible.
Beveled shims are to be used where necessary under bottom flanges of longitudinals where they rest on shelf angles of cross girders.
For details of feet of 12"x15" Posts. See Plan No 20329.
For details of feet of 15"x15" Posts See Plan No 20316.
BENT 214
BENT 213
BENT 212
CROSS GIRDER 218
CROSS GIRDER 217
CROSS GIRDER 216
CROSS GIRDER 215
20330


BOSTON ELEVATED RAILWAY
—ELEVATED CONSTRUCTION—
SOUTH APPROACH - WASHINGTON ST. TUNNEL
TRANSVERSE GIRDERS & COLS. - BENTS 1232 & 1240
Mar. 1906.
Section C-D
Section A-B
Section R-S
Detail of Expansion Pocket for Column
Section B-H
Section E-F
One-Half Bent 1240
One-Half Bent 1232
Section K-L
25737


BOSTON ELEVATED RAILWAY
—ELEVATED CONSTRUCTION—
SOUTH APPROACH-WASHINGTON ST. TUNNEL
DIAGRAMS OF BENTS
1230-1231-1233-1234-1236-1238-1239-1241-1242
CHIEF ENGINEER.
25743

BOSTON ELEVATED RAILWAY

—ELEVATED CONSTRUCTION—

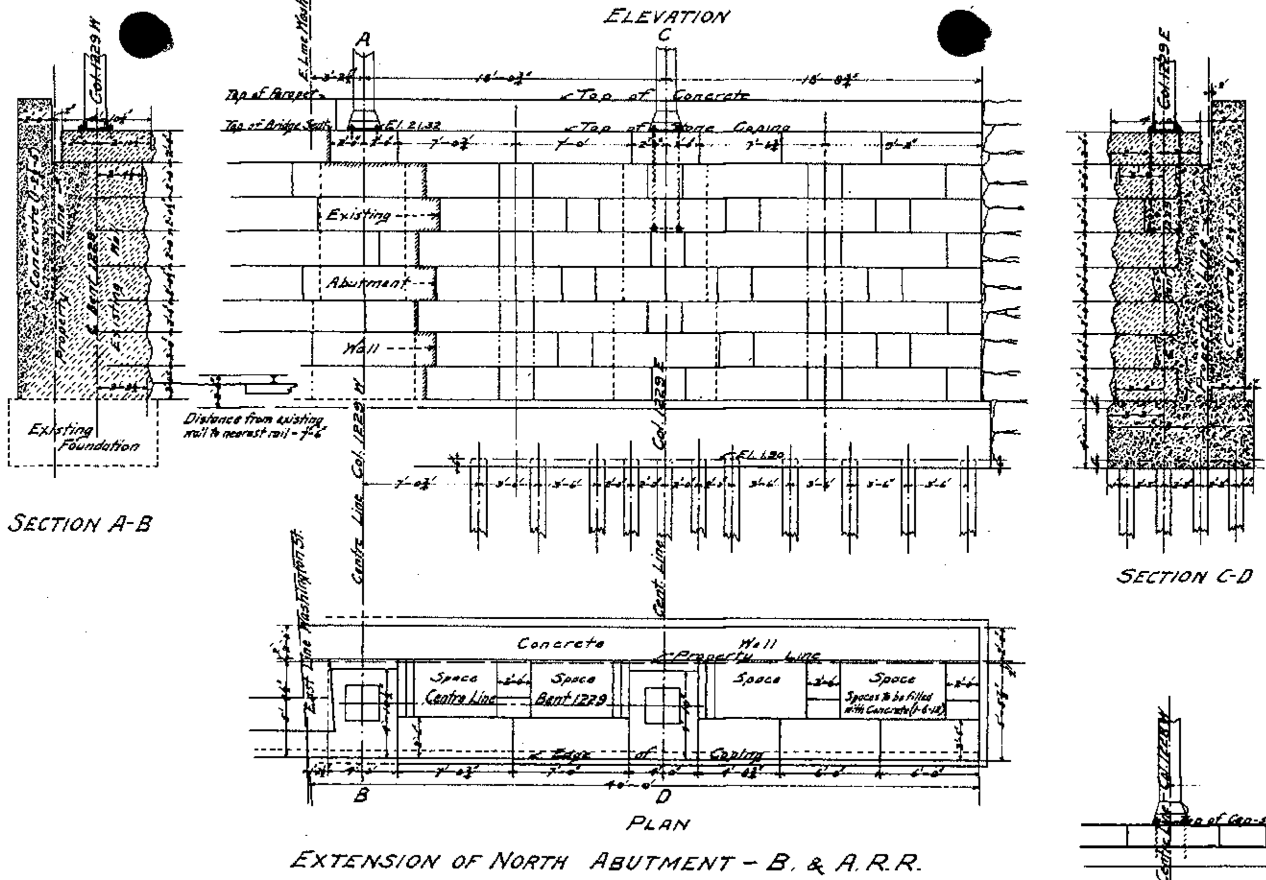
SOUTH APPROACH – WASHINGTON ST. TUNNEL

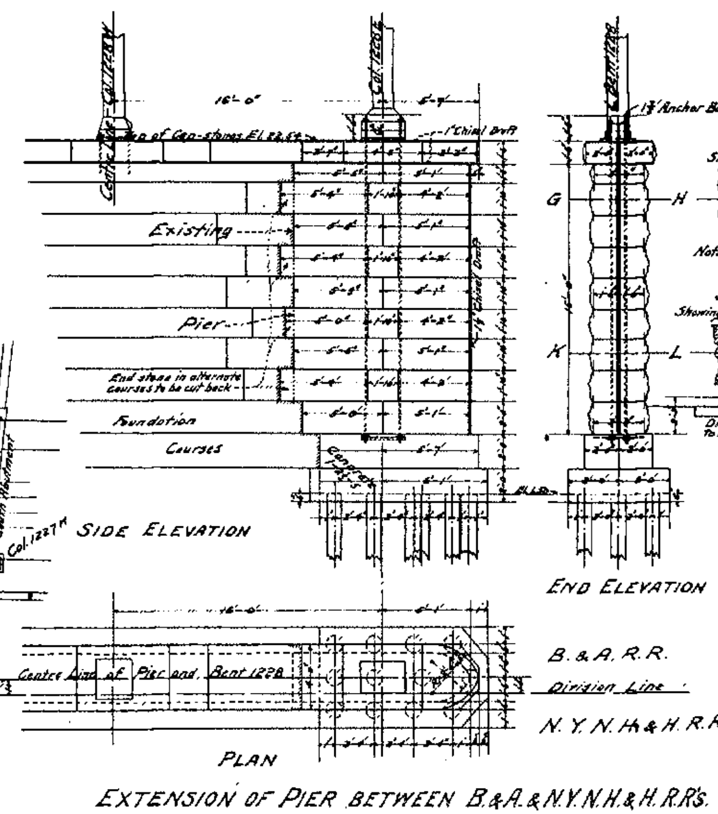
FOUNDATIONS FOR COLUMNS – BENTS 1227-1228-1229

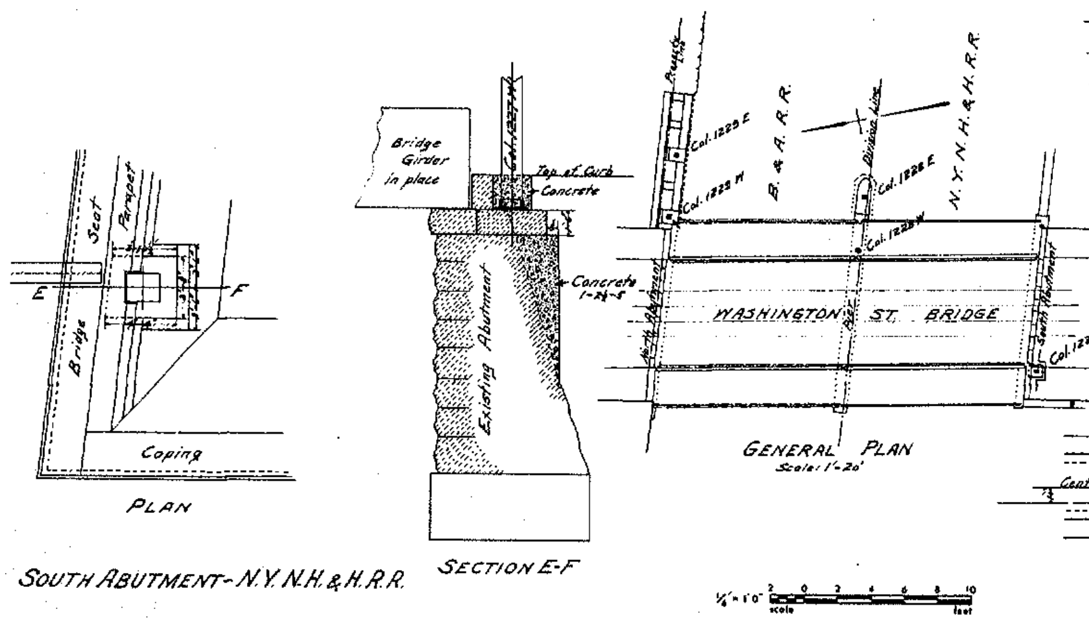
Scale: 1" = 4'   March, 1907.

Drawn by ....
Correct ....
.... Chief Engineer

Note:– All stones are to be quarry face, pitched to line. No projections beyond the pitch lines to exceed 4". All joints to be ½". No allowance has been made for joints in the dimensions given. Top surface of coping stones for North Abutment, cap stones for Pier, and of stone for South Abutment to be rough pointed.







M-ROLL 5 M

BOSTON ELEVATED RAILWAY
ELEVATED CONSTRUCTION
PLAN NO. 20575

Boston Elevated Railway Company
HAER No. MA-14 HD-33
Page 252

BOSTON ELEVATED RAILWAY

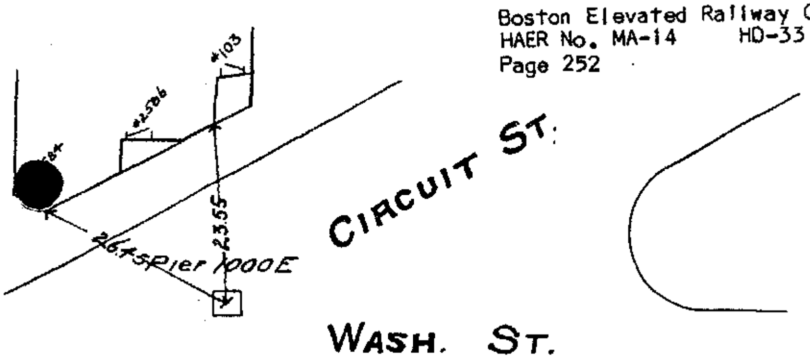
ELEVATED LINES

ROXBURY DIV.

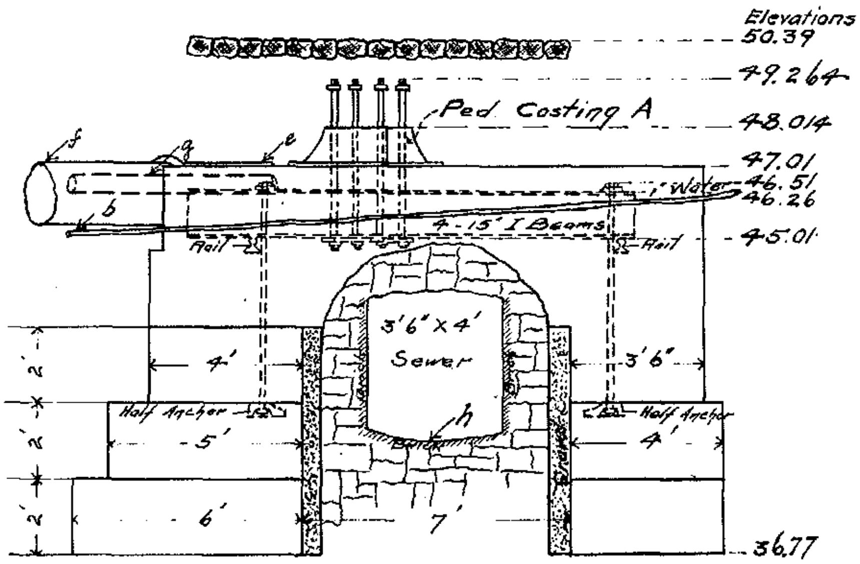
FOUNDATION FOR POST 1000 E. WASHINGTON ST. AT CIRCUIT ST.

Scale 1/4" = 1' Jan. 31, 1902.

George A. Kimball
CHIEF ENGINEER.

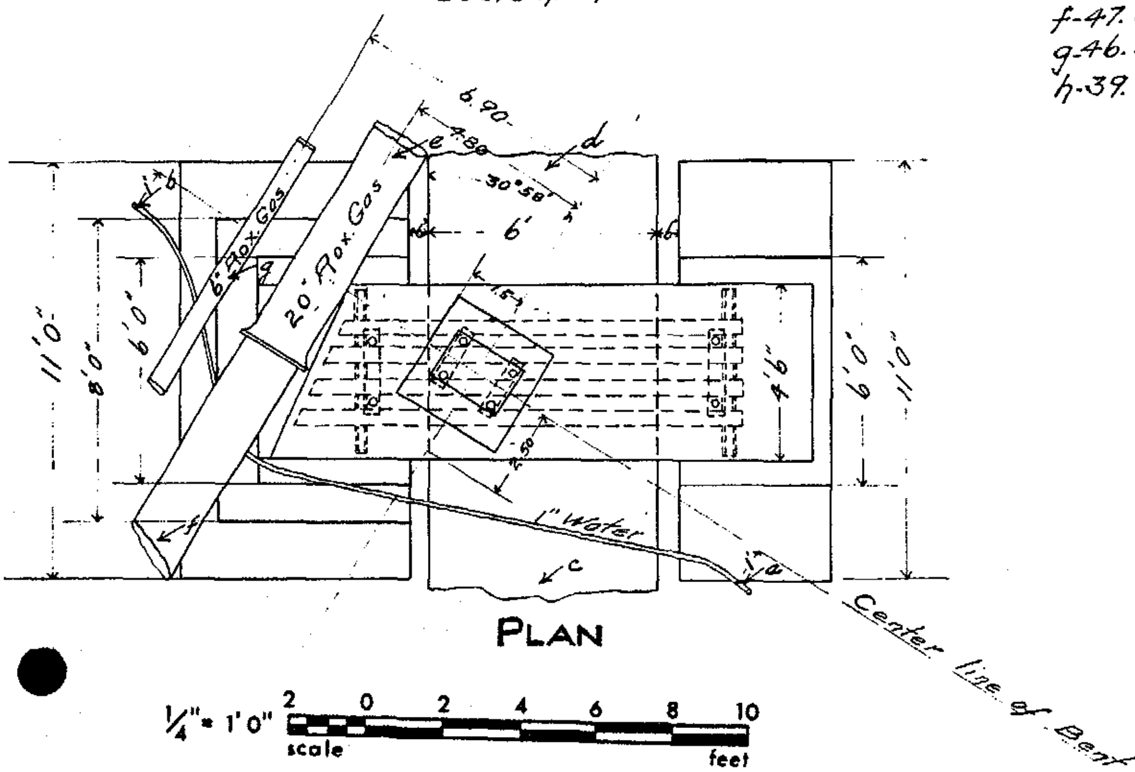


ale 20' = 1'



ELEVATION
Scale 1/4" = 1'

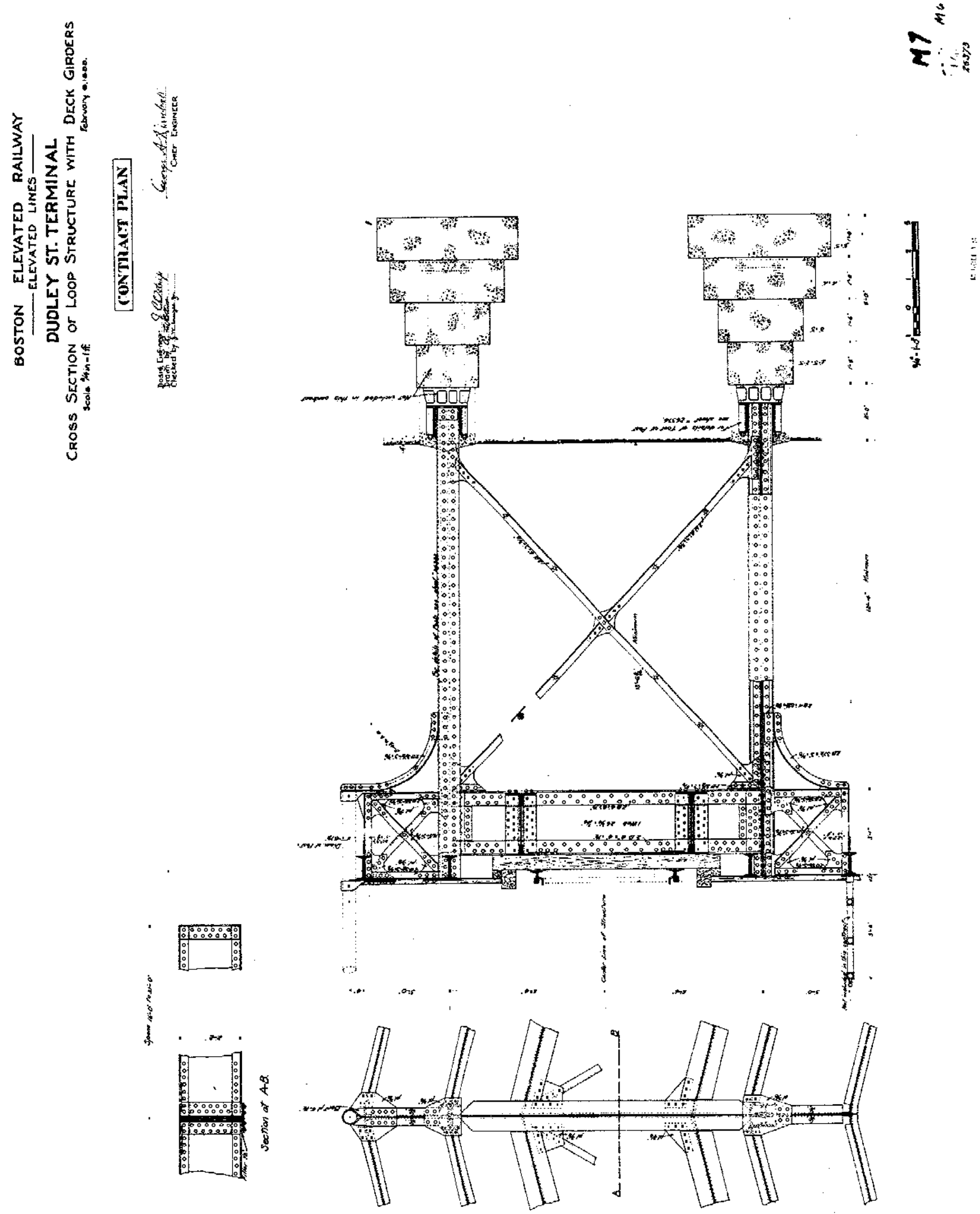
Elevations
a - 46.09
b - 45.33
c - 45.22
d - 45.07
e - 47.06
f - 47.31
g - 46.80
h - 39.77

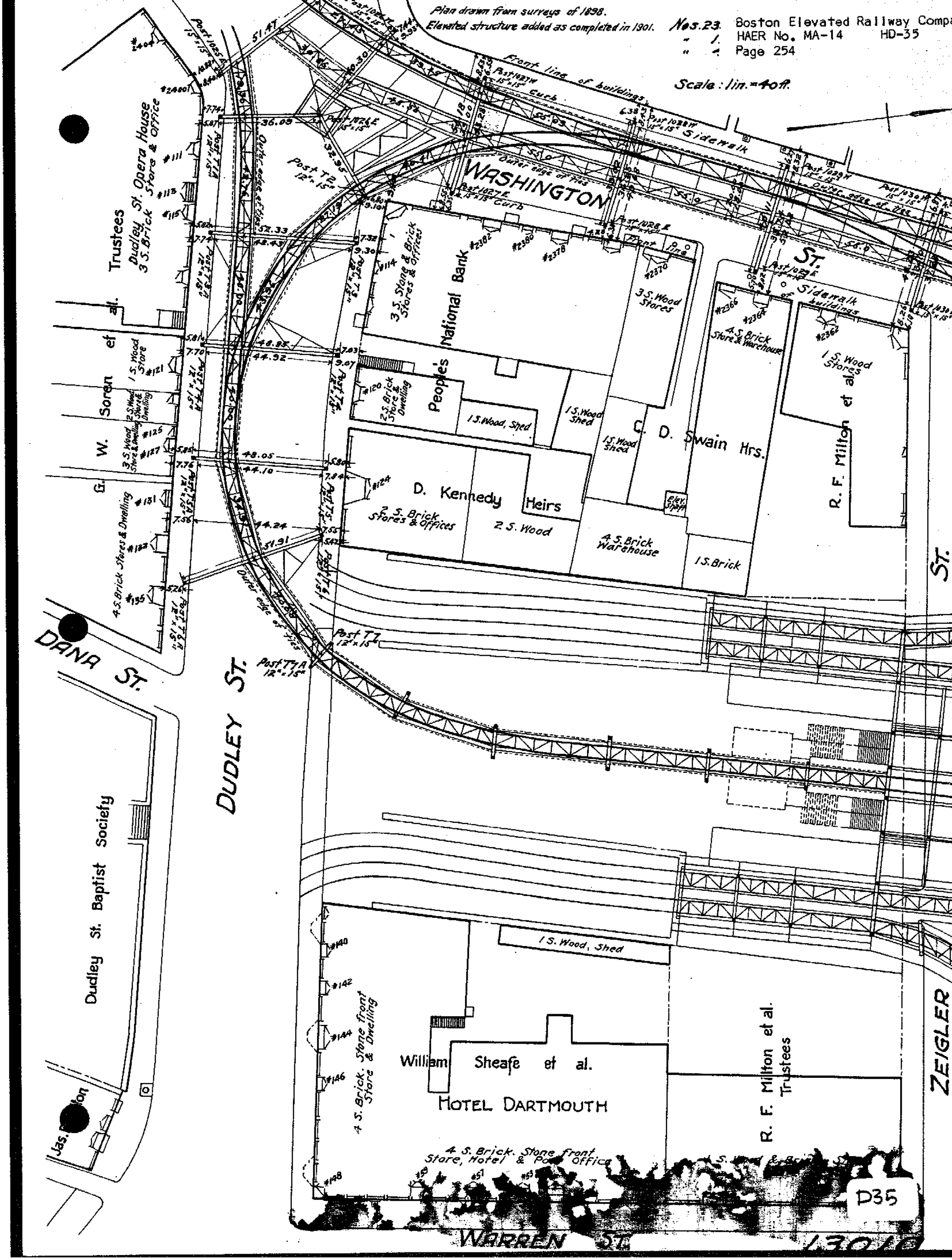


PLAN

1/4" = 1'0" scale 2 0 2 4 6 8 10 feet

11419


BOSTON ELEVATED RAILWAY
ELEVATED LINES
DUDLEY ST. TERMINAL
CROSS SECTION OF LOOP STRUCTURE WITH DECK GIRDERS
CONTRACT PLAN
Section at A-B.


Plan drawn from surveys of 1898.
Elevated structure added as completed in 1901.
Nos. 23.
" 1.
" 1.
Scale: 1in.=40ft.
WASHINGTON ST.
DUDLEY ST.
DANA ST.
ZEIGLER ST.
WARREN ST.
Dudley St. Baptist Society
Trustees
Dudley St. Opera House
3 S. Brick Store & Office
G. W. Soren et al.
People's National Bank
3 S. Stone & Brick Stores & Offices
D. Kennedy Heirs
2 S. Brick Stores & Offices
2 S. Wood
4 S. Brick Warehouse
1 S. Brick
C. D. Swain Hrs.
R. F. Milton et al.
1 S. Wood Stores
4 S. Brick Store & Warehouse
3 S. Wood Stores
William Sheafe et al.
HOTEL DARTMOUTH
4 S. Brick. Stone front Store & Dwelling
4 S. Brick. Stone front Store, Hotel & Post Office
R. F. Milton et al. Trustees
1 S. Wood, Shed
4 S. Brick Stores & Dwelling
Post T7 12"x15"
Post T7A 12"x15"
Post T2 12"x15"
Front line of buildings
Sidewalk
Curb
Outer edge of ties
D35

BOSTON ELEVATED RAILWAY

ELEVATED LINES

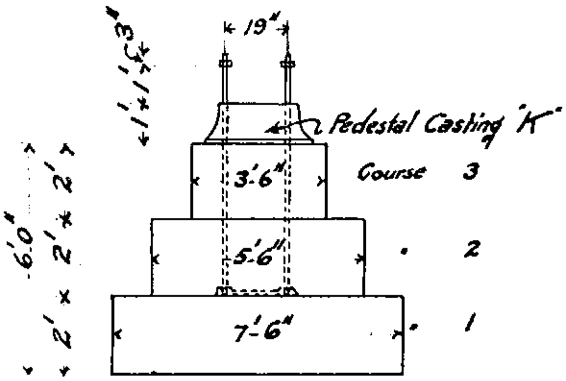
TYPICAL FOUNDATION

BASE 7'6" x 7'6" 3 COURSES

Scale: 1/4" = 1'   Feb. 23, 1906

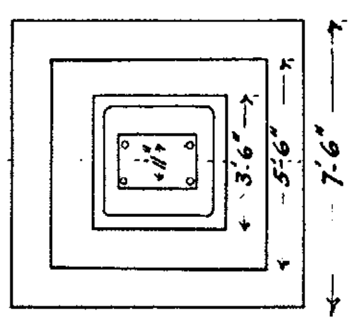
George A. Kimball

CHIEF ENGINEER



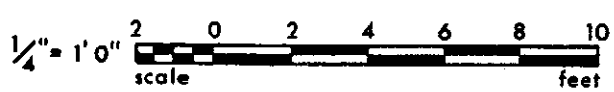
Foundation to be of Portland Cement Concrete mixed in the proportion 1:2½:5

ELEVATION

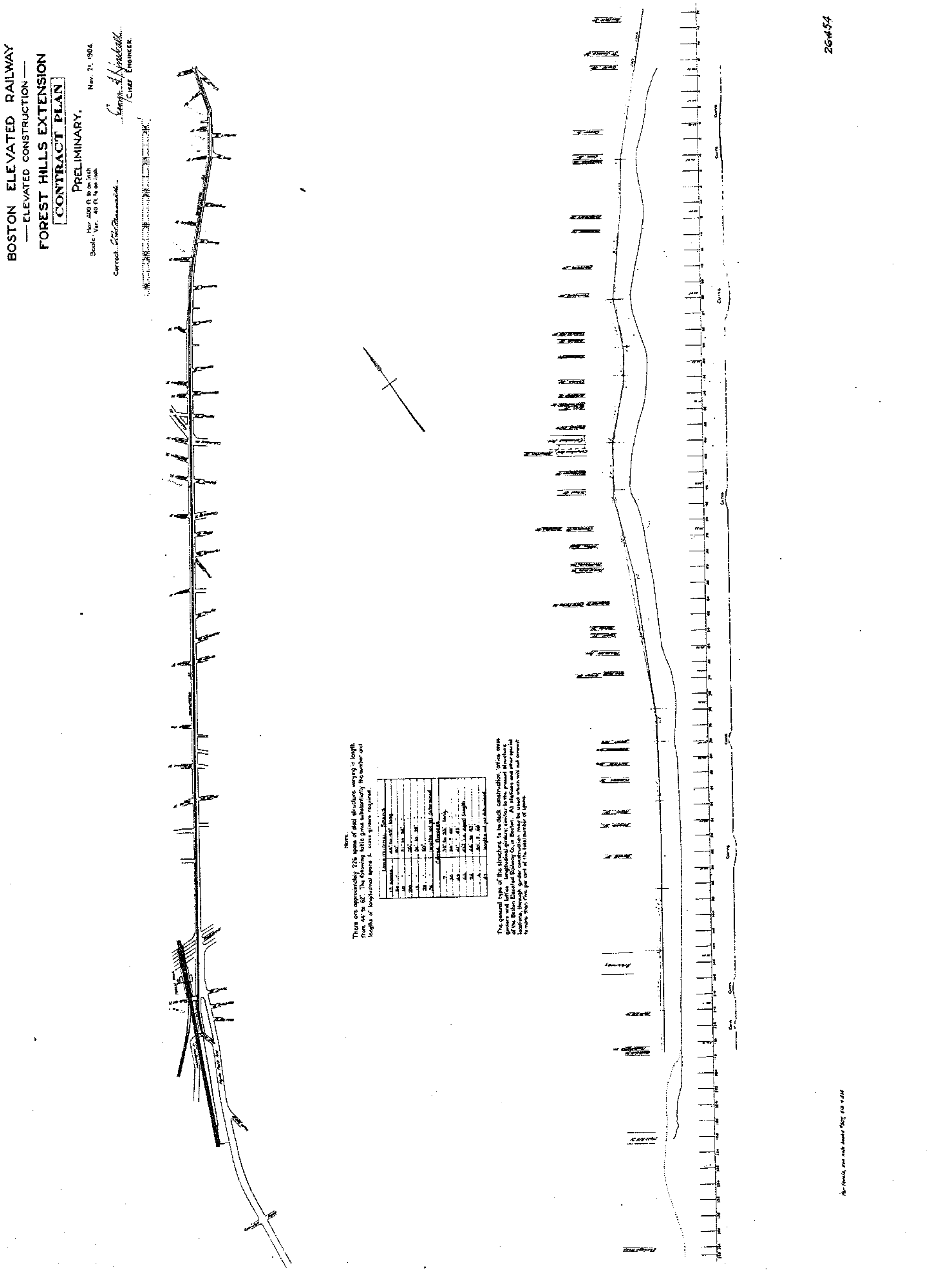


Center line of Bent

PLAN



11423 D36


BOSTON ELEVATED RAILWAY
— ELEVATED CONSTRUCTION —
FOREST HILLS EXTENSION
CONTRACT PLAN
PRELIMINARY.
Nov. 21, 1904.
Scale. Hor. 400 ft. to an inch
Ver. 40 ft. to an inch
Correct
Chief Engineer.
Note.
There are approximately 226 spans of steel structure varying in length from 44' to 62'. The following table gives substantially the number and lengths of longitudinal spans & cross girders required.
Longitudinal Spans
Cross Girders
The general type of the structure to be deck construction, lattice cross girders and lattice longitudinal girders; similar to the present structure of the Boston Elevated Railway Co., in Boston. At stations and other special locations, through girder construction may be used which will not amount to more than five per cent of the total number of spans.
26454

BOSTON ELEVATED RAILWAY

ELEVATED & SUBWAY CONSTRUCTION

FOREST HILLS EXTENSION

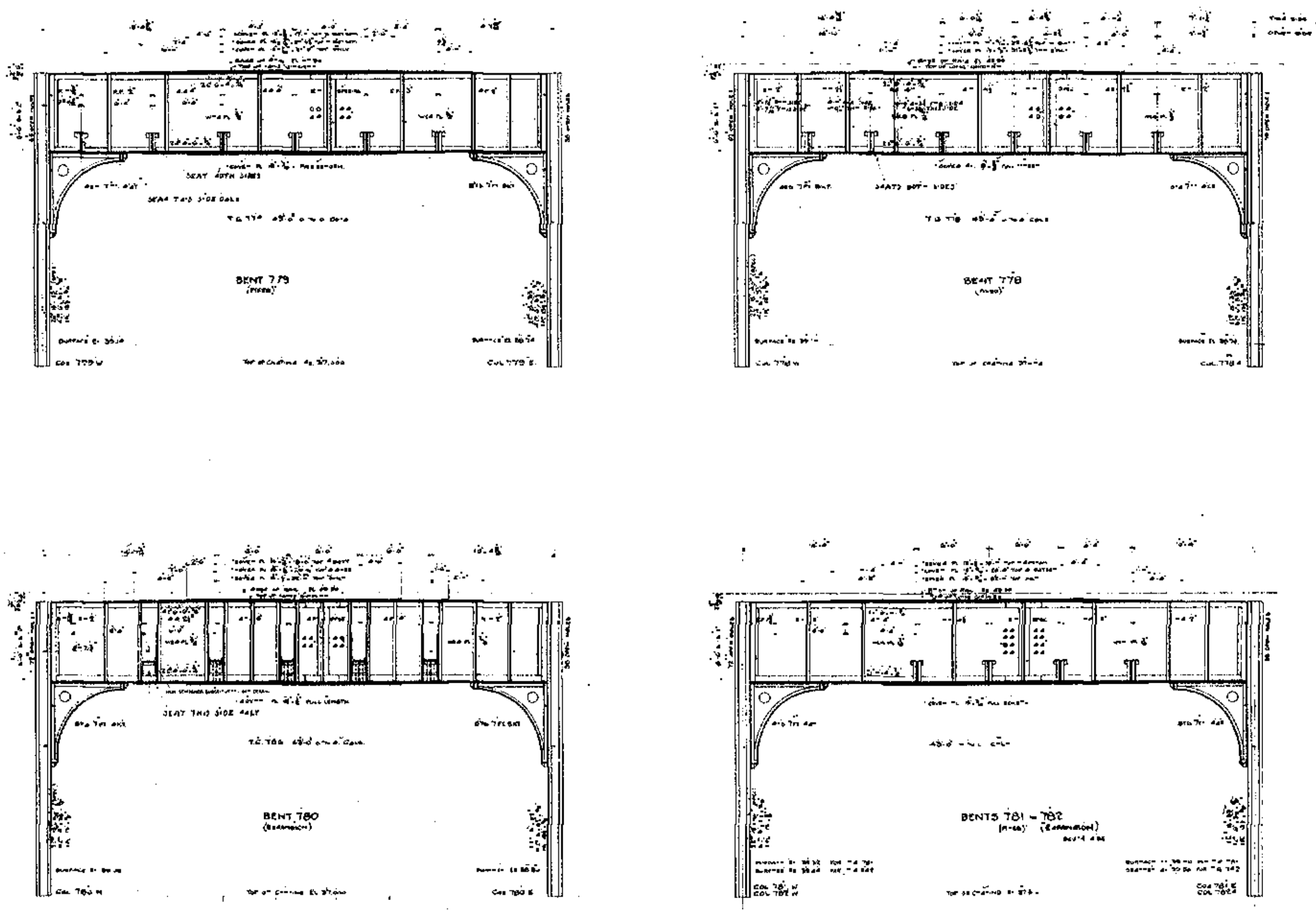
DIAGRAM OF BENTS 778-782

Scale 1/4" = 1 ft. Feb. 1908

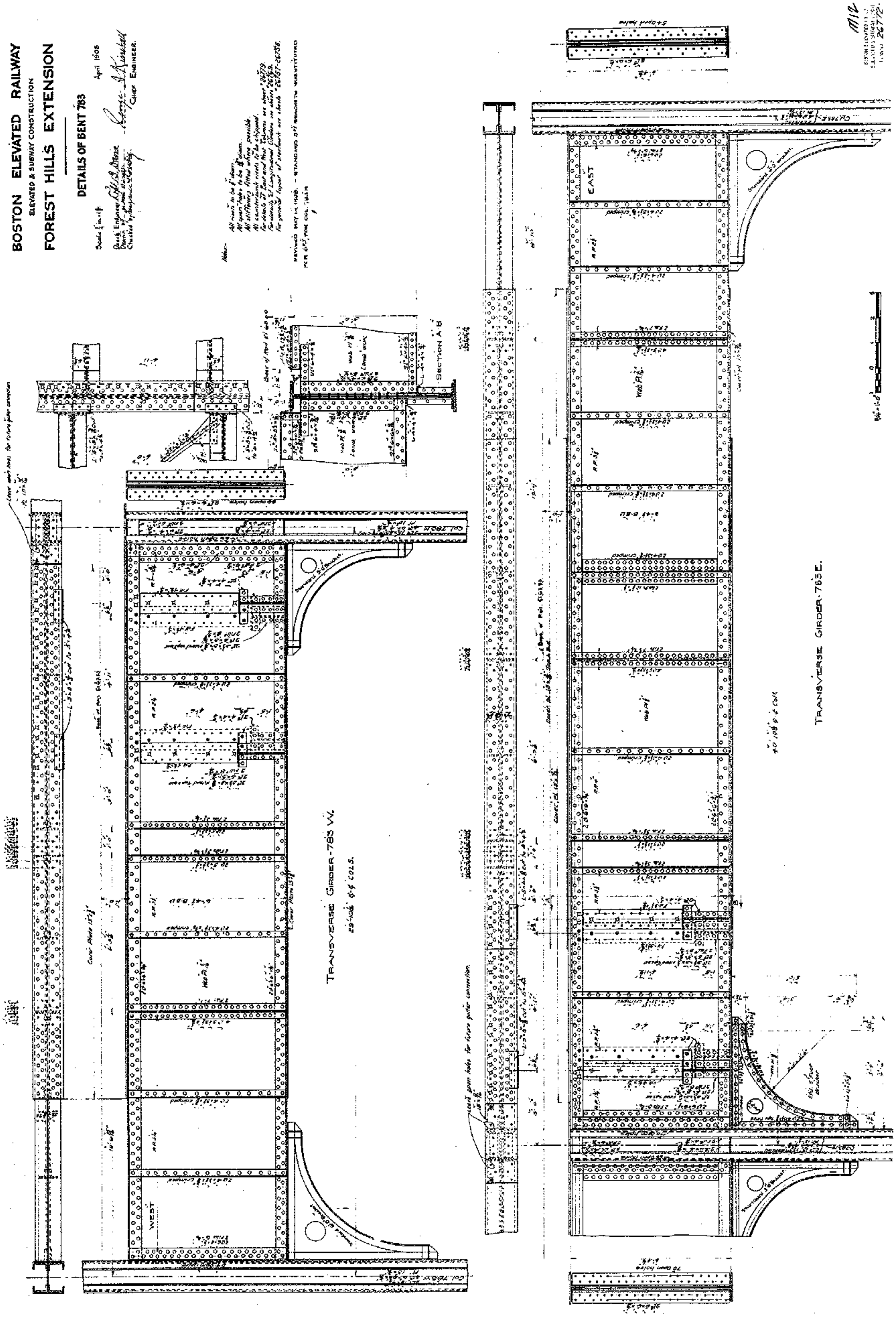
Chief Engineer.

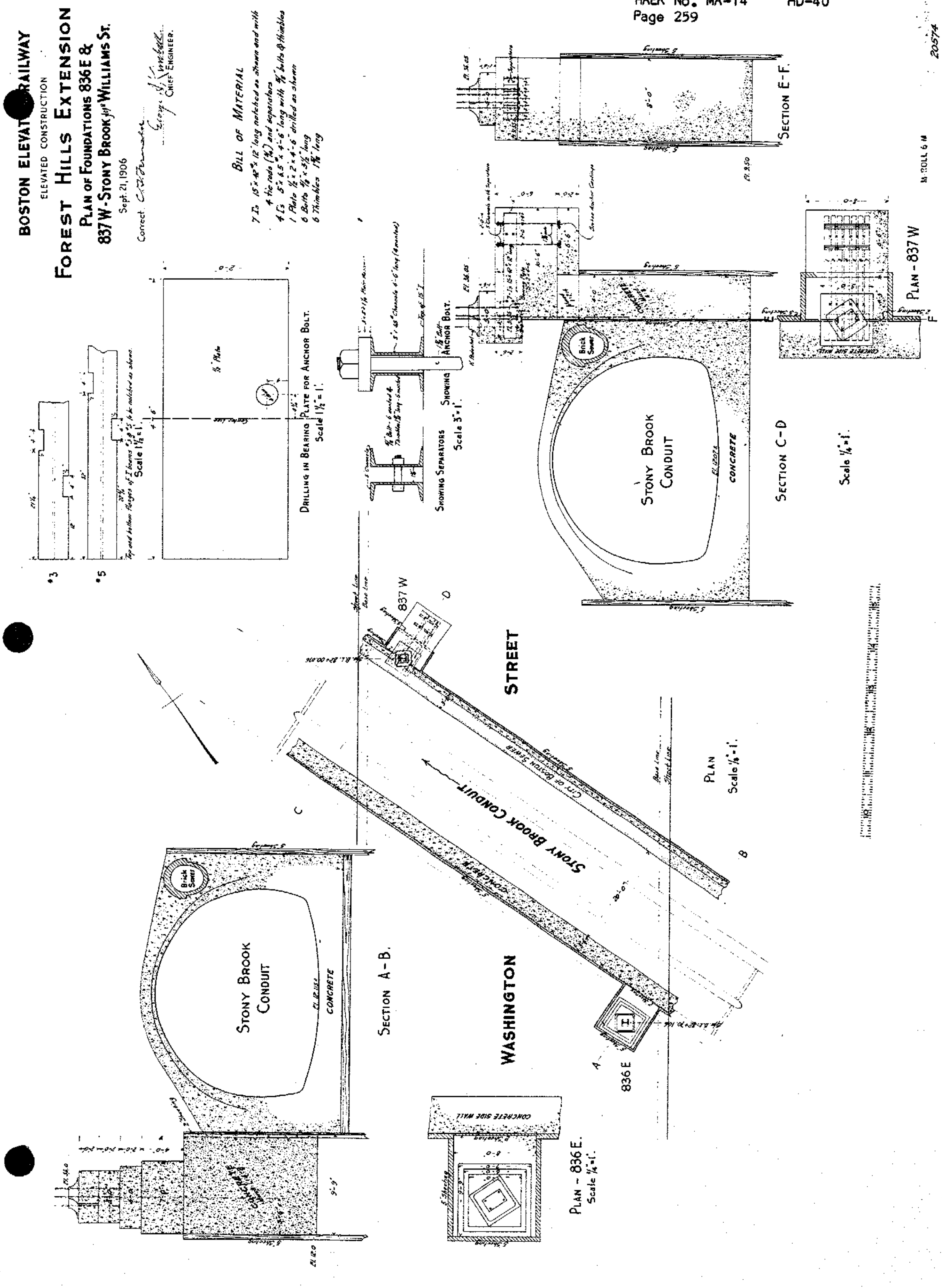
Revised March 31, 1908 — T.G. 782 made expansion on south side.

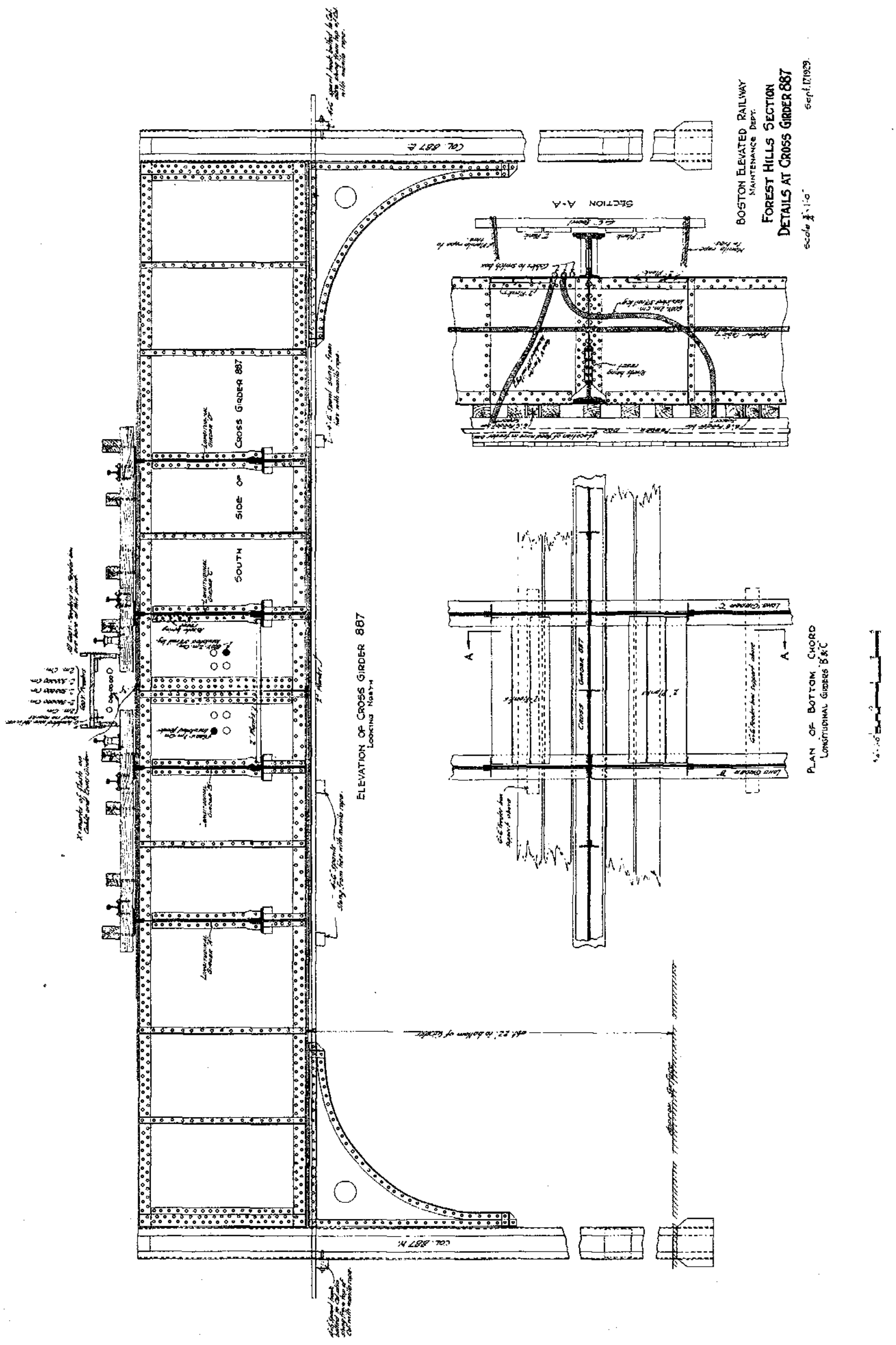
Revised March 1, 1930 — T.G. 780. Seat added west end south side



Notes -


BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS EXTENSION
DETAILS OF BENT 783
April 1905
CHIEF ENGINEER.
TRANSVERSE GIRDER-783 W.
TRANSVERSE GIRDER-783 E.
SECTION A-B
WEST
EAST


BOSTON ELEVATED RAILWAY
ELEVATED CONSTRUCTION
FOREST HILLS EXTENSION
PLAN OF FOUNDATIONS 836 E &
837 W - STONY BROOK OPP. WILLIAMS ST.
Sept. 21, 1906
Correct.
CHIEF ENGINEER.
BILL OF MATERIAL
7 Is 15" x 42# 12' long notched as shown and with 4 tie rods (3/4") and separators
4 Cs 5" x 6.5# x 4'-6" long with 3/4" bolts & thimbles
1 Plate 1/2" x 2' x 4'-6" drilled as shown
6 Bolts 3/4" x 3 1/2" long
6 Thimbles 1 3/4" long
Scale 1 1/2" = 1'.
DRILLING IN BEARING PLATE FOR ANCHOR BOLT.
SHOWING SEPARATORS
SHOWING ANCHOR BOLT.
Scale 3" = 1'.
SECTION E-F.
Brick Sewer
STONY BROOK CONDUIT
CONCRETE
SECTION C-D
Scale 1/4" = 1'.
PLAN - 837 W
CONCRETE SIDE WALL
837 W
STREET
CITY OF BOSTON SEWER
STONY BROOK CONDUIT
PLAN
Scale 1/8" = 1'.
WASHINGTON
836 E
SECTION A-B.
PLAN - 836 E.
Scale 1/4" = 1'.
20574


BOSTON ELEVATED RAILWAY
MAINTENANCE DEPT.
FOREST HILLS SECTION
DETAILS AT CROSS GIRDER 887
Sept. 17, 1929
SECTION A-A
ELEVATION OF CROSS GIRDER 887
LOOKING NORTH
SOUTH SIDE OF CROSS GIRDER 887
PLAN OF BOTTOM CHORD
LONGITUDINAL GIRDERS 'B' & 'C'
COL. 887 E.
COL. 887 W.

BOSTON ELEVATED RAILWAY
—— ELEVATED CONSTRUCTION ——
FOREST HILLS EXTENSION

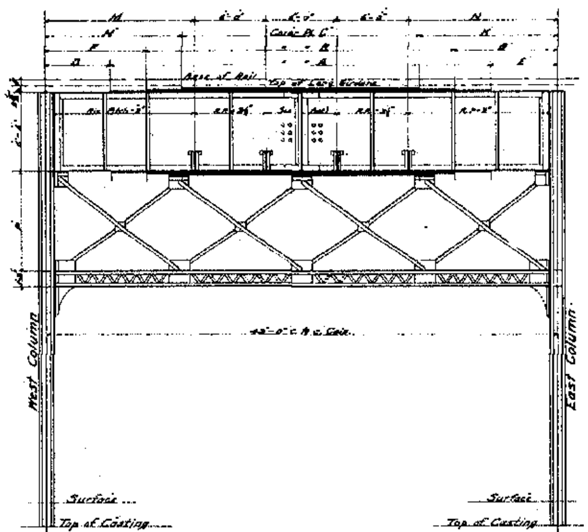
DIAGRAM FOR BENTS 920-932

April 21, 1905.

Desig. Engineer Robt. B. Davis
Drawn by H. N. Wahlberg
Checked by Benjamin Hawley

George A. Kimball
CHIEF ENGINEER

Revised for El.-Top of Casting, Cols. 922 E & W, Nov. 25, 1905.



BENTS 920 TO 932

TABLE OF DATA FOR BENTS 920 TO 932

Trans. Girder		Chords			M	N	Plate A	D	E	Plate B	F	G	Plate C	H	K
T.G. 920	Fixed	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 921	Expansion	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 922	Fixed	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 923	"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 924	Expansion	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 925	Fixed	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 926	"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 927	Expansion	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 928	Fixed	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 929	"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 930	Expansion	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 931	Fixed	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 932	"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Columns	Special I	Angles	Web	Base of Rail	Top of Casting	Surface	Milled Length	P	[illegible]
Col. 920W	[illegible]	[illegible]	[illegible]	107.910	74.813	77.43	32'-3⅝"	7'-6"	68
" 920E	[illegible]	[illegible]	[illegible]	"	"	77.33	"	"	62
Col. 921W	[illegible]	[illegible]	[illegible]	103.709	75.809	75.33	32'-3⅝"	8'-3"	59
" 921E	[illegible]	[illegible]	[illegible]	"	"	75.45	"	"	66
Col. 922W	[illegible]	[illegible]	[illegible]	106.593	[illegible]	77.20	35'-9⅝"	8'-3"	58
" 922E	[illegible]	[illegible]	[illegible]	"	71.908*	73.65	"	"	33
Col. 923W	[illegible]	[illegible]	[illegible]	104.309	38.787	71.18	34'-9⅝"	9'-0"	58
" 923E	[illegible]	[illegible]	[illegible]	"	"	71.70	"	"	64
Col. 924W	[illegible]	[illegible]	[illegible]	103.378	67.373	69.94	34'-9⅝"	9'-0"	58
" 924E	[illegible]	[illegible]	[illegible]	"	"	70.85	"	"	64
Col. 925W	[illegible]	[illegible]	[illegible]	135.243	63.938	68.68	35'-3⅝"	9'-0"	58
" 925E	[illegible]	[illegible]	[illegible]	"	37.033	69.33	34'-9⅝"	"	38
Col. 926W	[illegible]	[illegible]	[illegible]	101.183	66.183	63.80	34'-3⅝"	9'-0"	58
" 926E	[illegible]	[illegible]	[illegible]	"	"	69.74	"	"	66
Col. 927W	[illegible]	[illegible]	[illegible]	100.049	65.649	67.94	33'-9⅝"	8'-3"	58
" 927E	[illegible]	[illegible]	[illegible]	"	"	63.26	"	"	66
Col. 928W	[illegible]	[illegible]	[illegible]	98.940	36.440	67.71	33'-9⅝"	8'-3"	58
" 928E	[illegible]	[illegible]	[illegible]	"	"	67.72	"	"	62
Col. 929W	[illegible]	[illegible]	[illegible]	98.035	36.083	67.89	32'-3⅝"	7'-6"	53
" 929E	[illegible]	[illegible]	[illegible]	"	"	37.68	"	"	68
Col. 930W	[illegible]	[illegible]	[illegible]	97.523	34.536	67.61	32'-3⅝"	7'-6"	48
" 930E	[illegible]	[illegible]	[illegible]	"	"	63.70	"	"	53
Col. 931W	[illegible]	[illegible]	[illegible]	97.233	34.238	66.70	32'-3⅝"	7'-6"	58
" 931E	[illegible]	[illegible]	[illegible]	"	"	63.34	"	"	53
Col. 932W	[illegible]	[illegible]	[illegible]	97.600	33.700	66.23	33'-9⅝"	7'-6"	53
" 932E	[illegible]	[illegible]	[illegible]	"	"	66.03	"	"	58

* Original Table of data changed.

Notes:—

For typical details of Transverse Girders and Columns, showing stiffeners, splice plates, and connection angles, etc.—see Sheet 25396.

Cover plates may be slightly lengthened to suit details.

The Trolley holes through webs of girders are 3½" in diameter.

For details of Transverse Bracing see Sheet 26715.

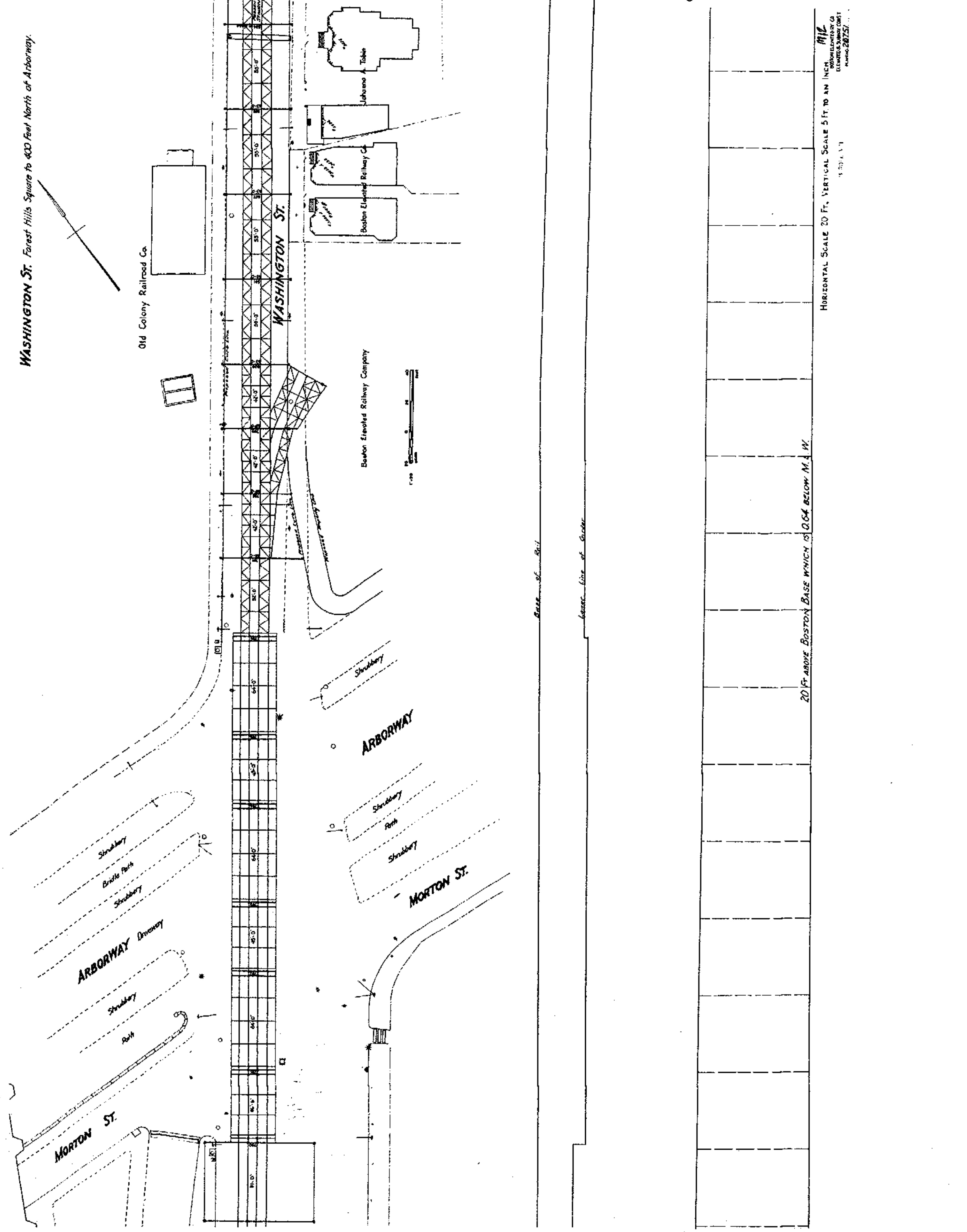
For general drawings of Longitudinal Girders, bracing, etc.—see Sheets 25700, 26701 and 26702.

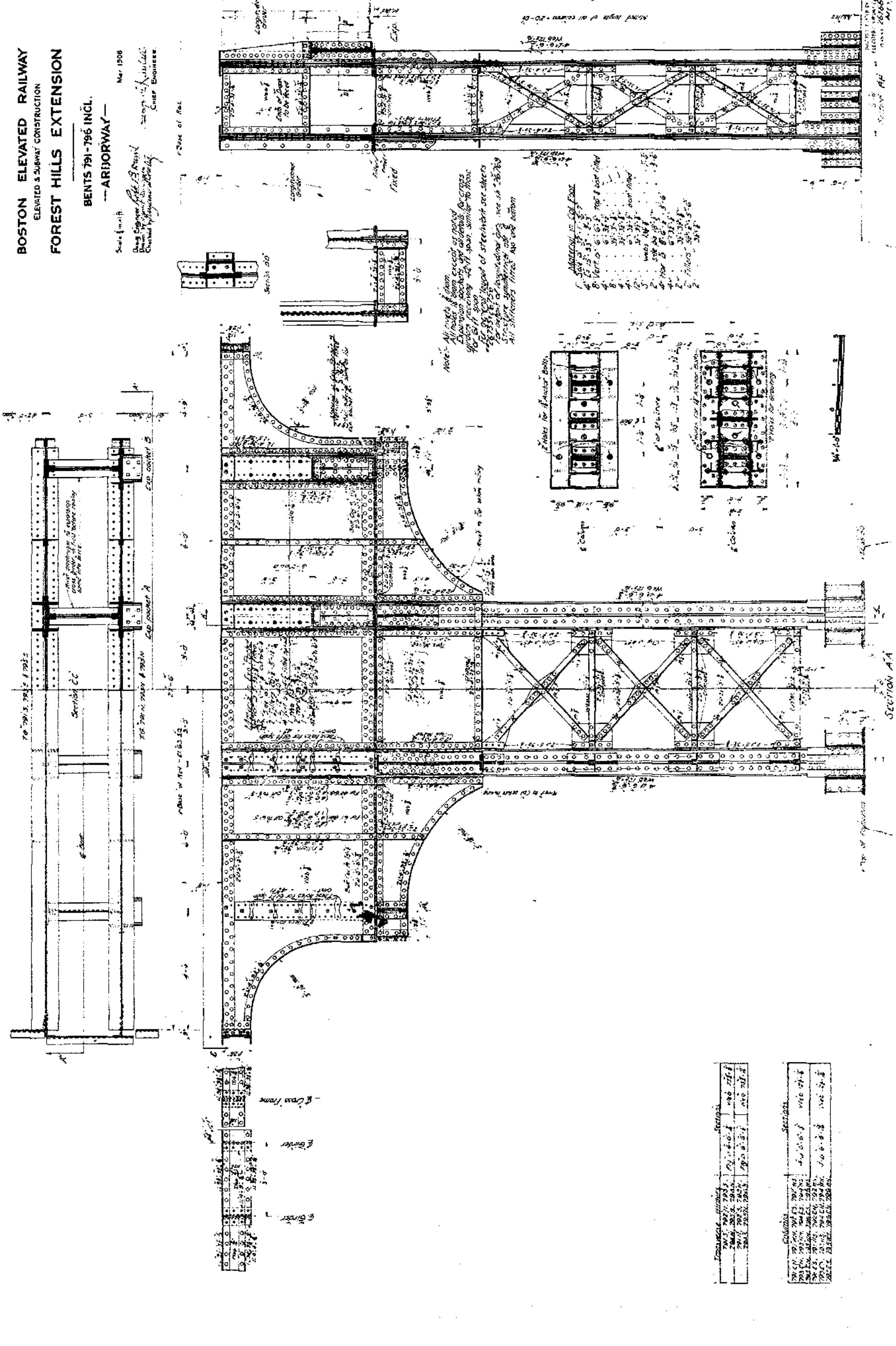
Surface elevations shown are gutter elevations. The plates on columns to be located so that tops of same will not be less than 3'-6" nor more than 4'-6" above given elevation.

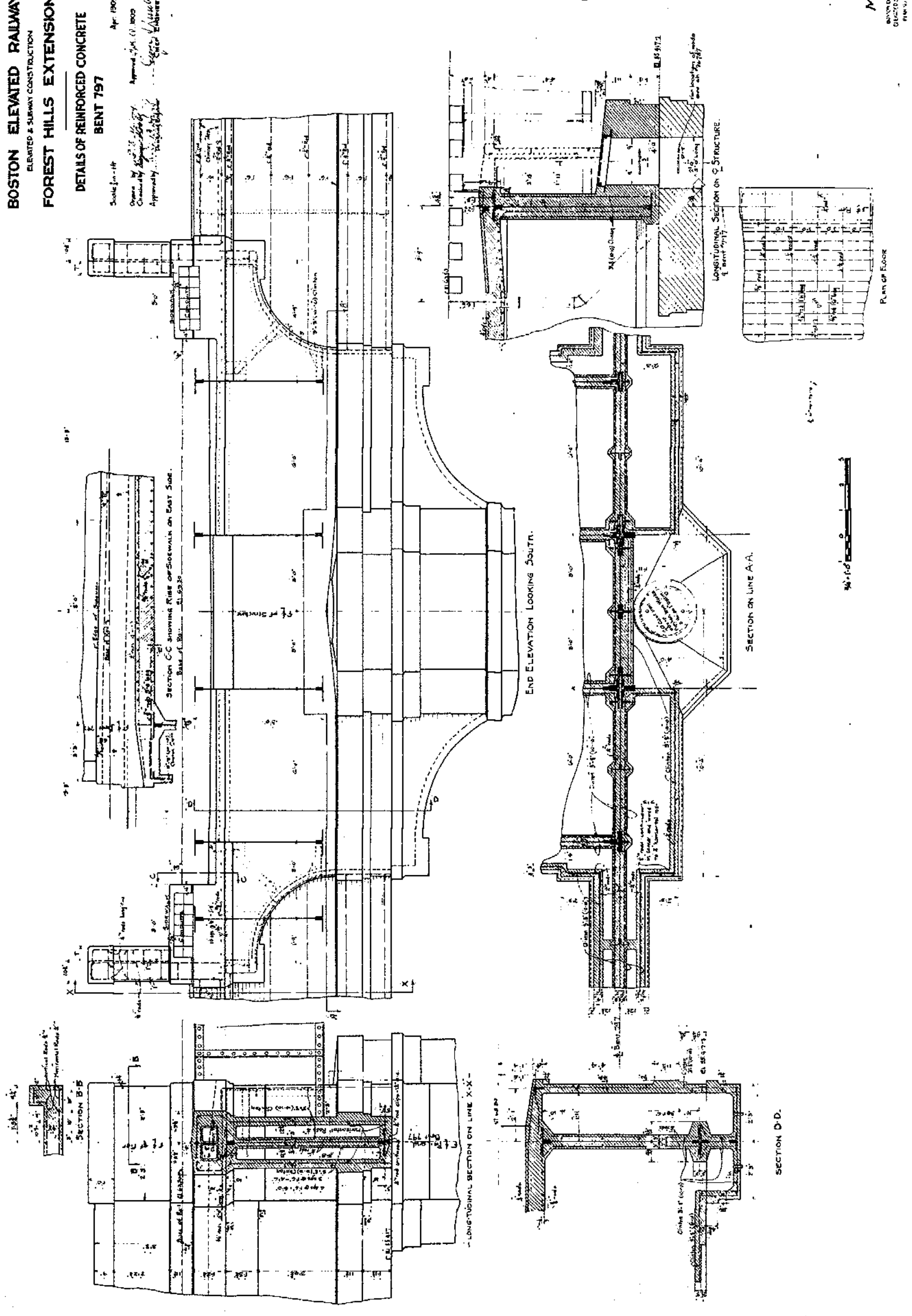
Bents 920 to 932

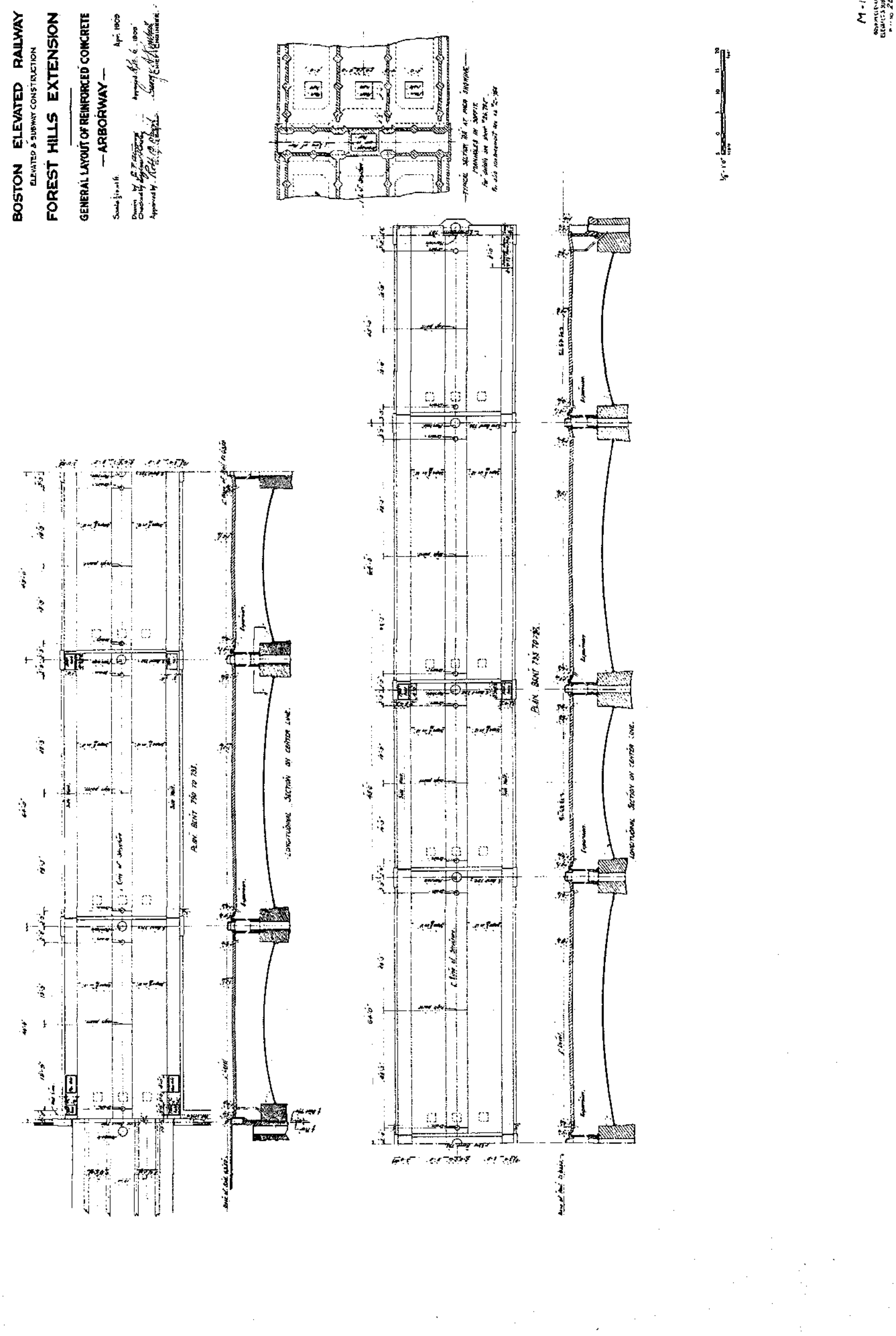
M-12

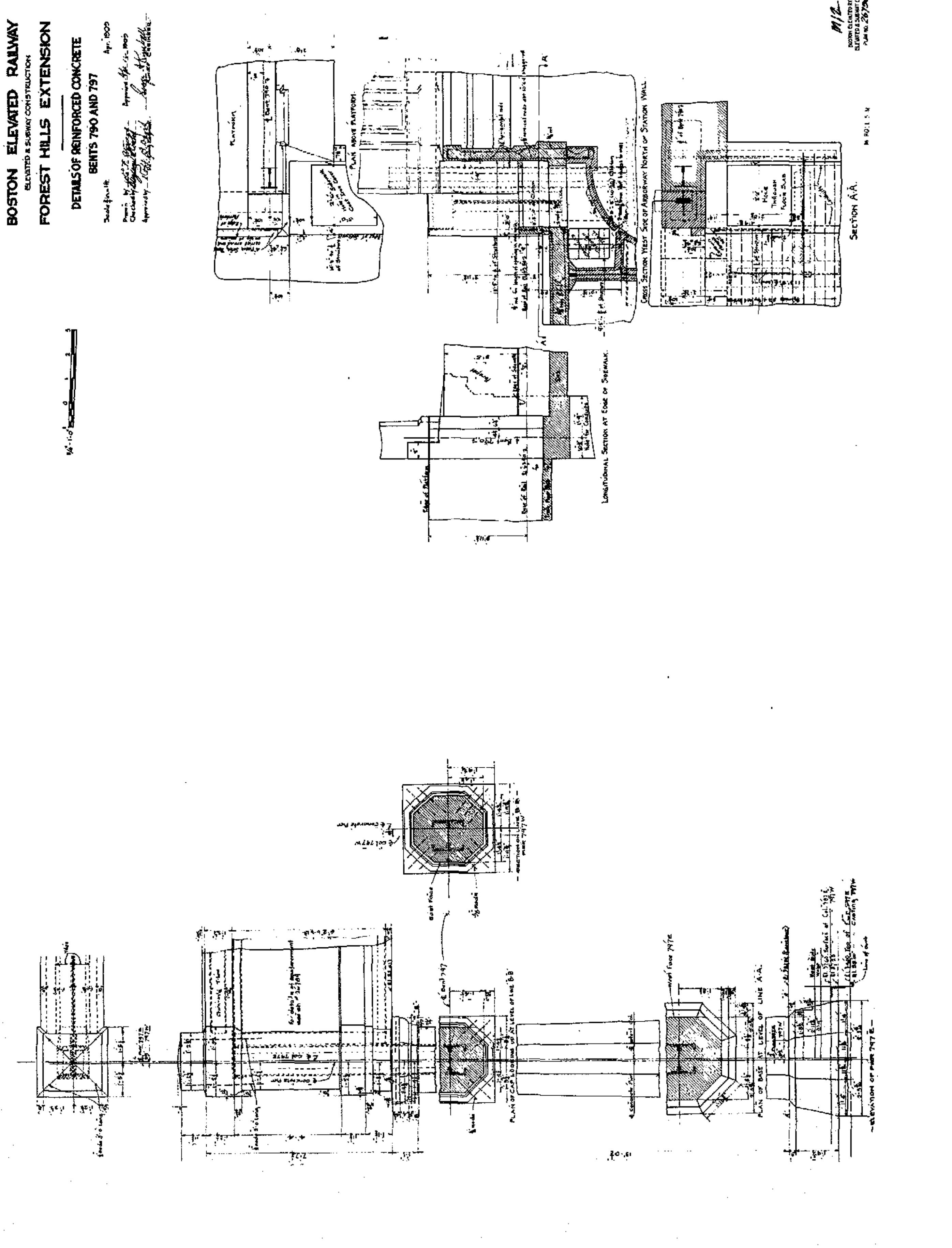
26714

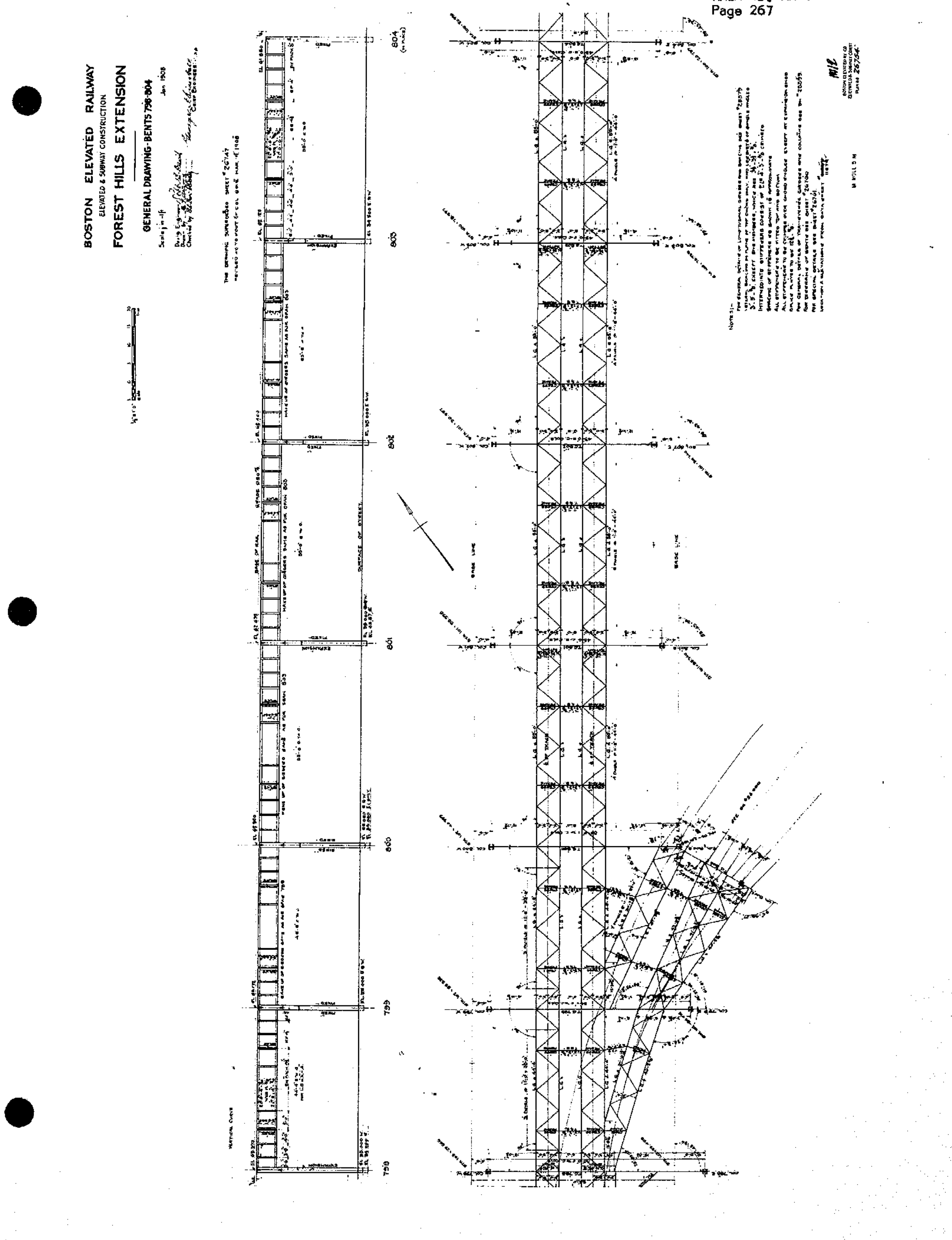

WASHINGTON ST. Forest Hills Square to 400 Feet North of Arborway.
Old Colony Railroad Co.
WASHINGTON ST.
Johanna A. Tobin
Boston Elevated Railway Co.
Boston Elevated Railway Company
ARBORWAY
Shrubbery
Path
Shrubbery
MORTON ST.
Shrubbery
Bridle Path
Shrubbery
ARBORWAY Driveway
Shrubbery
Path
MORTON ST.
Base of Rail
Lower Line of Girder
20 Ft above Boston Base which is 0.64 below M. L. W.
Horizontal Scale 20 Ft, Vertical Scale 5 Ft to an Inch

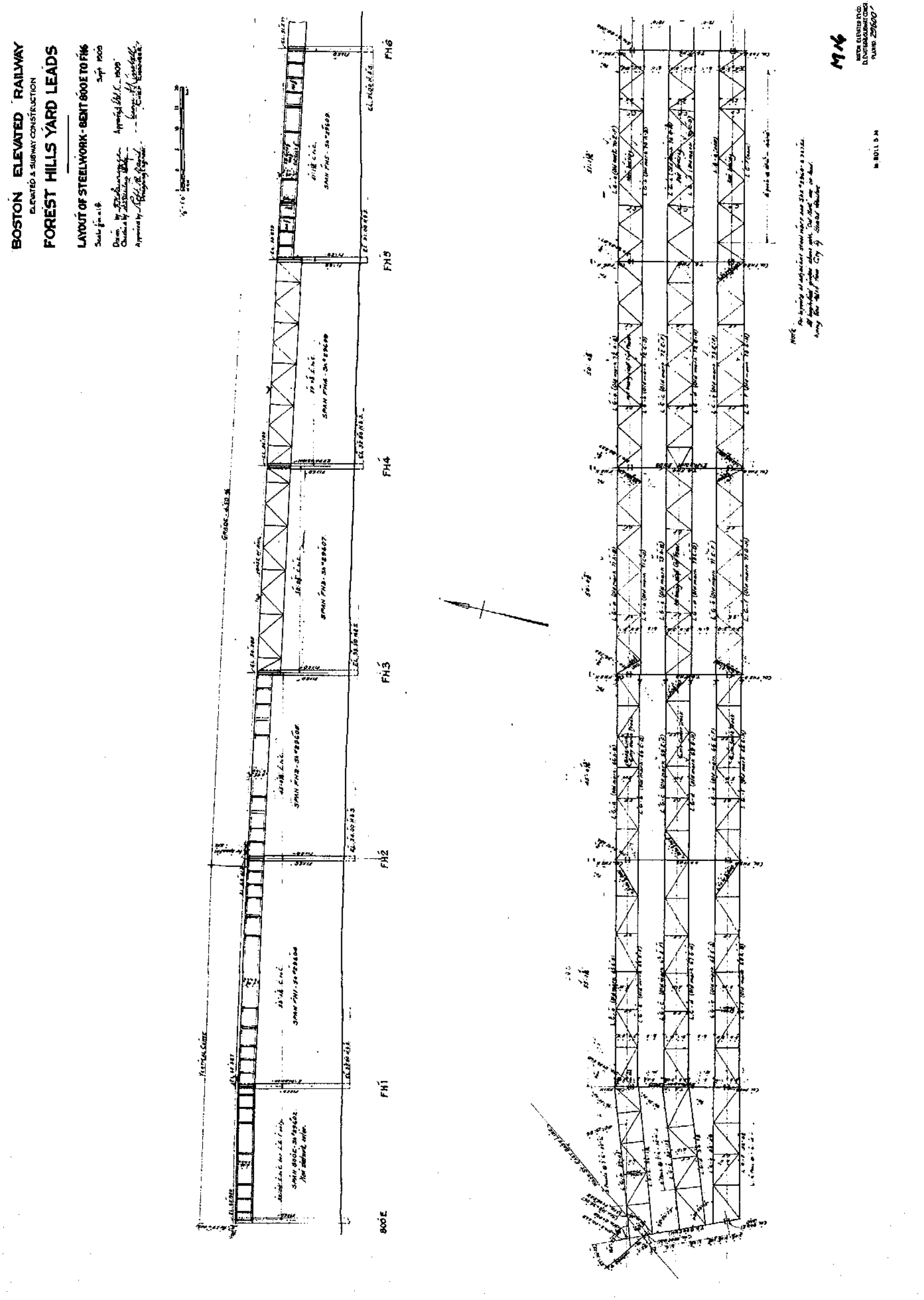

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS EXTENSION
BENTS 791-796 INCL.
—ARBORWAY—
Mar. 1908
SECTION A-A
Section C-C
Section D-D


BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS EXTENSION
DETAILS OF REINFORCED CONCRETE
BENT 797
Apr. 1909
SECTION C-C SHOWING RISE OF SIDEWALK ON EAST SIDE.
END ELEVATION LOOKING SOUTH.
SECTION ON LINE A-A.
LONGITUDINAL SECTION ON ℄ STRUCTURE.
PLAN OF FLOOR
SECTION B-B
LONGITUDINAL SECTION ON LINE X-X
SECTION D-D.
M-12

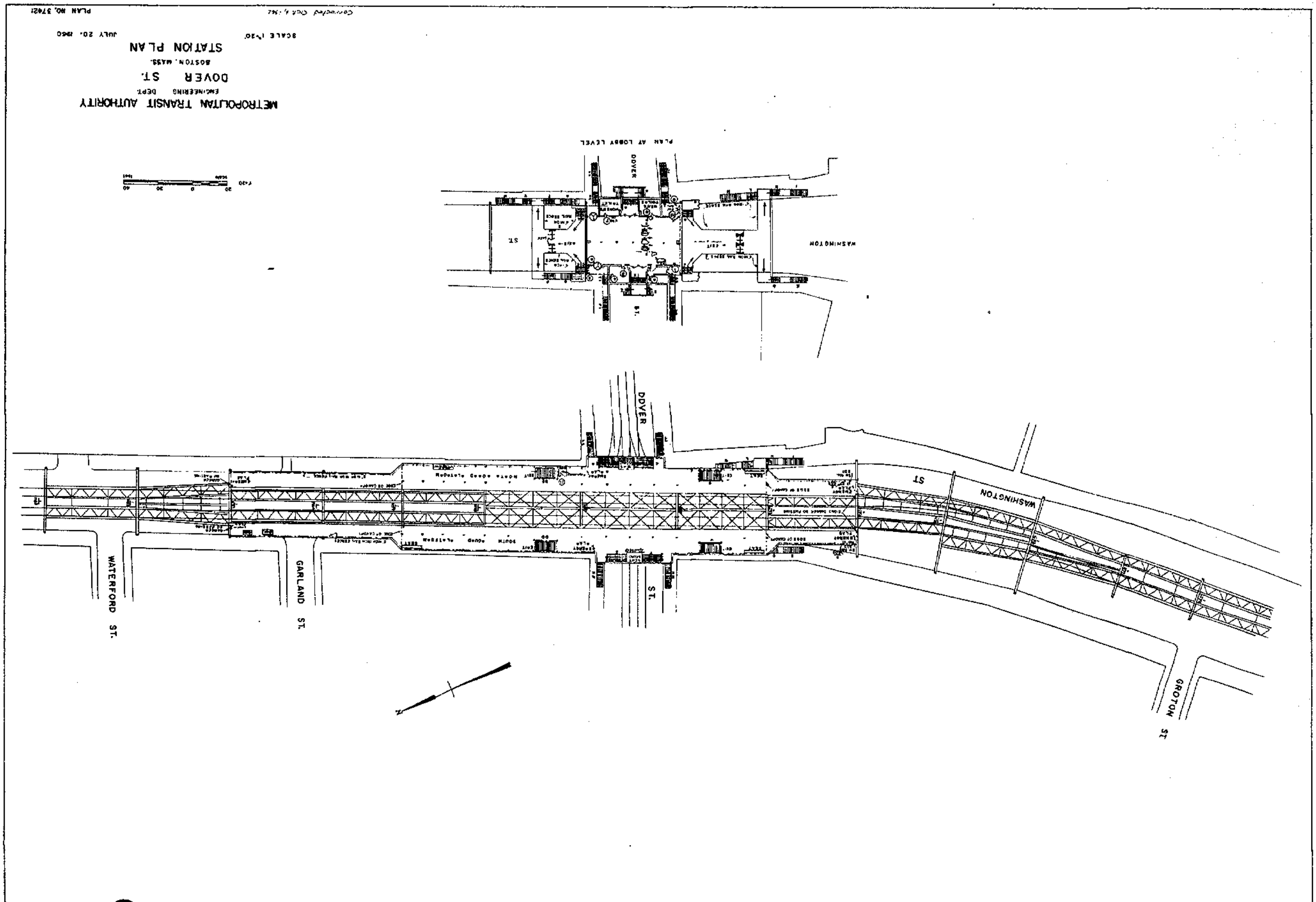

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS EXTENSION
GENERAL LAYOUT OF REINFORCED CONCRETE
— ARBORWAY —
M-12

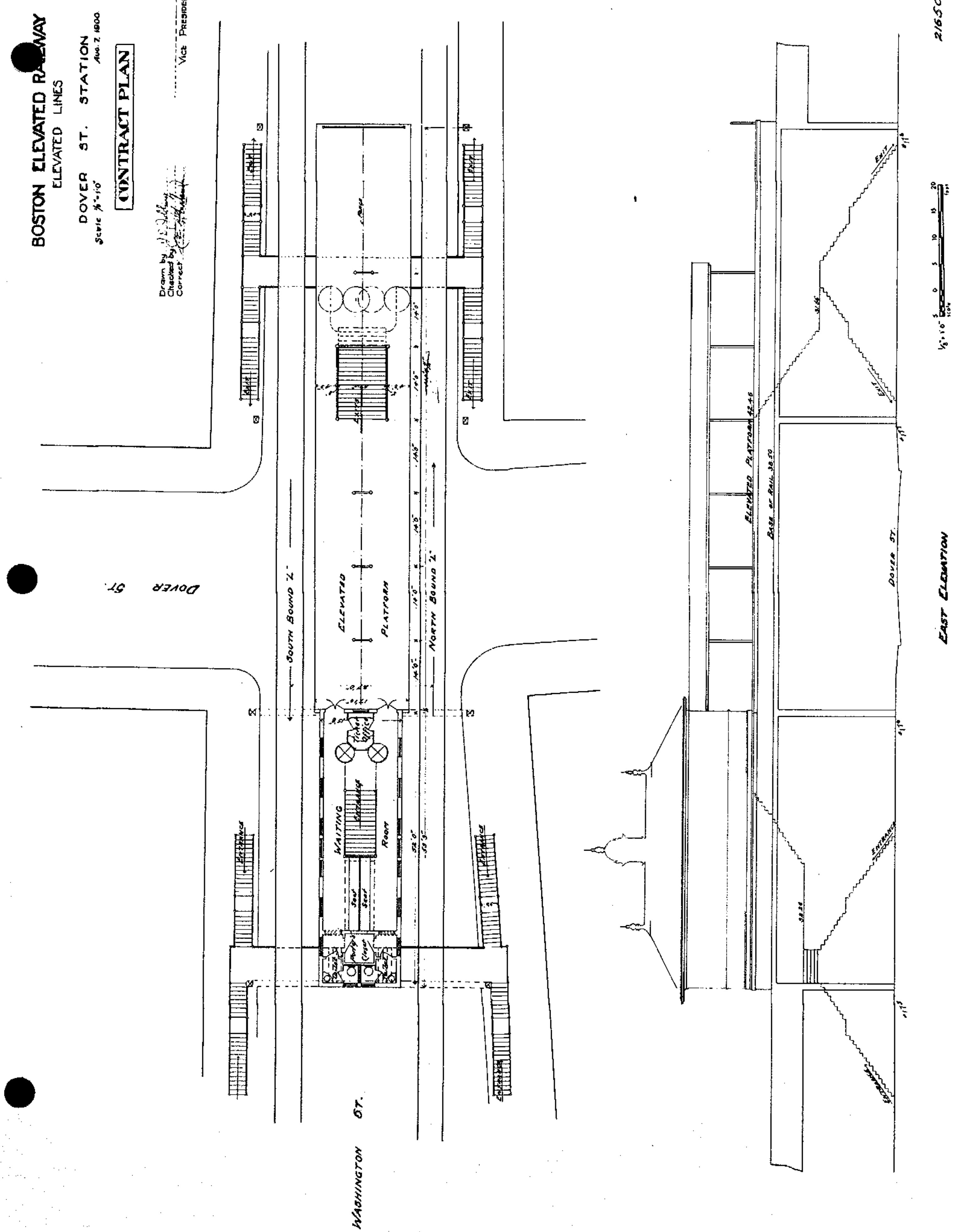

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS EXTENSION
DETAILS OF REINFORCED CONCRETE
BENTS 790 AND 797
CROSS SECTION WEST SIDE OF ARBORWAY NORTH OF STATION WALL
SECTION A-A
LONGITUDINAL SECTION AT EDGE OF SIDEWALK
PLAN ABOVE PLATFORM
ELEVATION OF PIER 797E

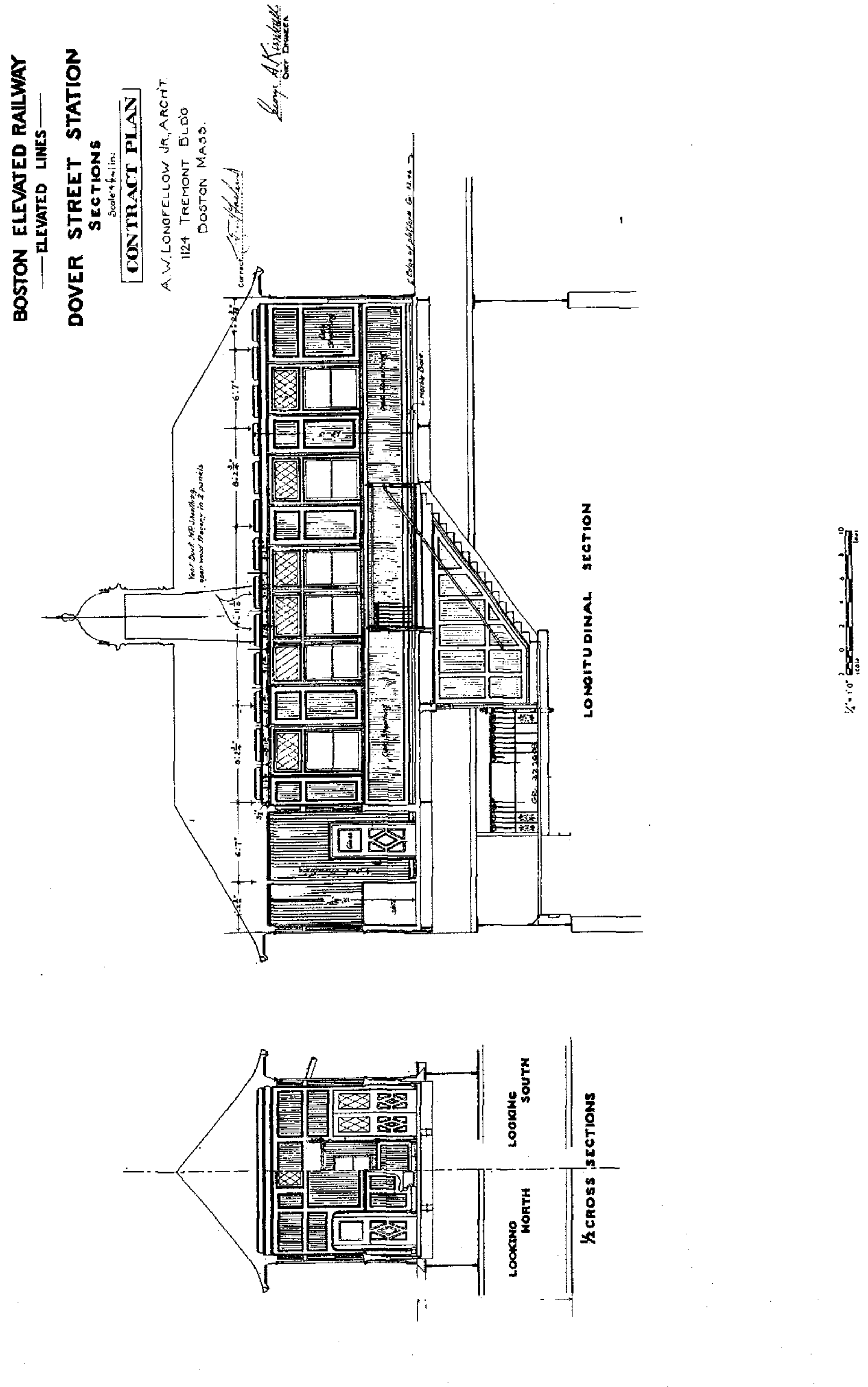

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS EXTENSION
GENERAL DRAWING-BENTS 798-804
Jan 1908
804
803
802
801
800
799
798
NOTES:-

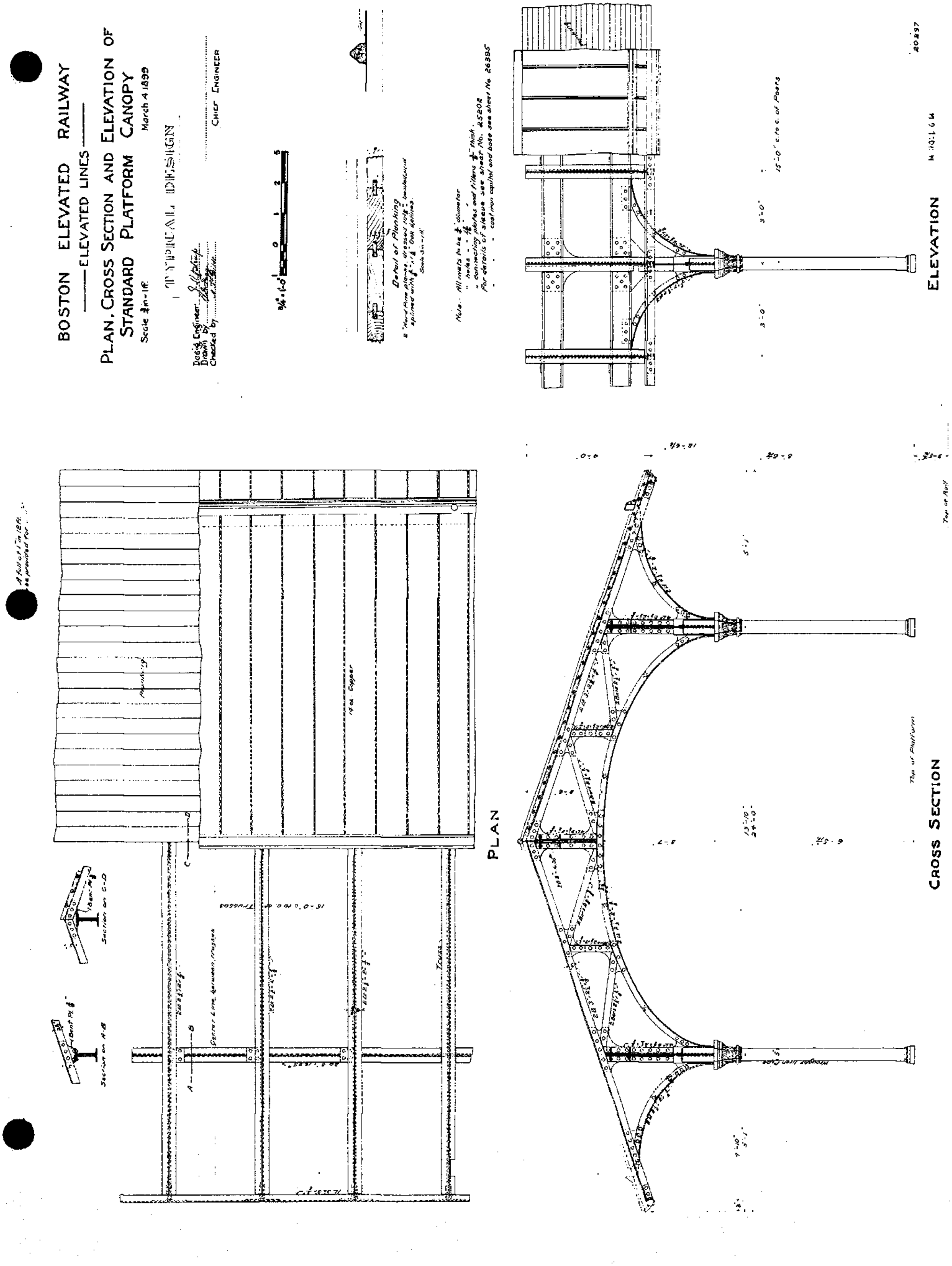

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS YARD LEADS
LAYOUT OF STEELWORK - BENT 800E TO FH6
800E
FH1
FH2
FH3
FH4
FH5
FH6

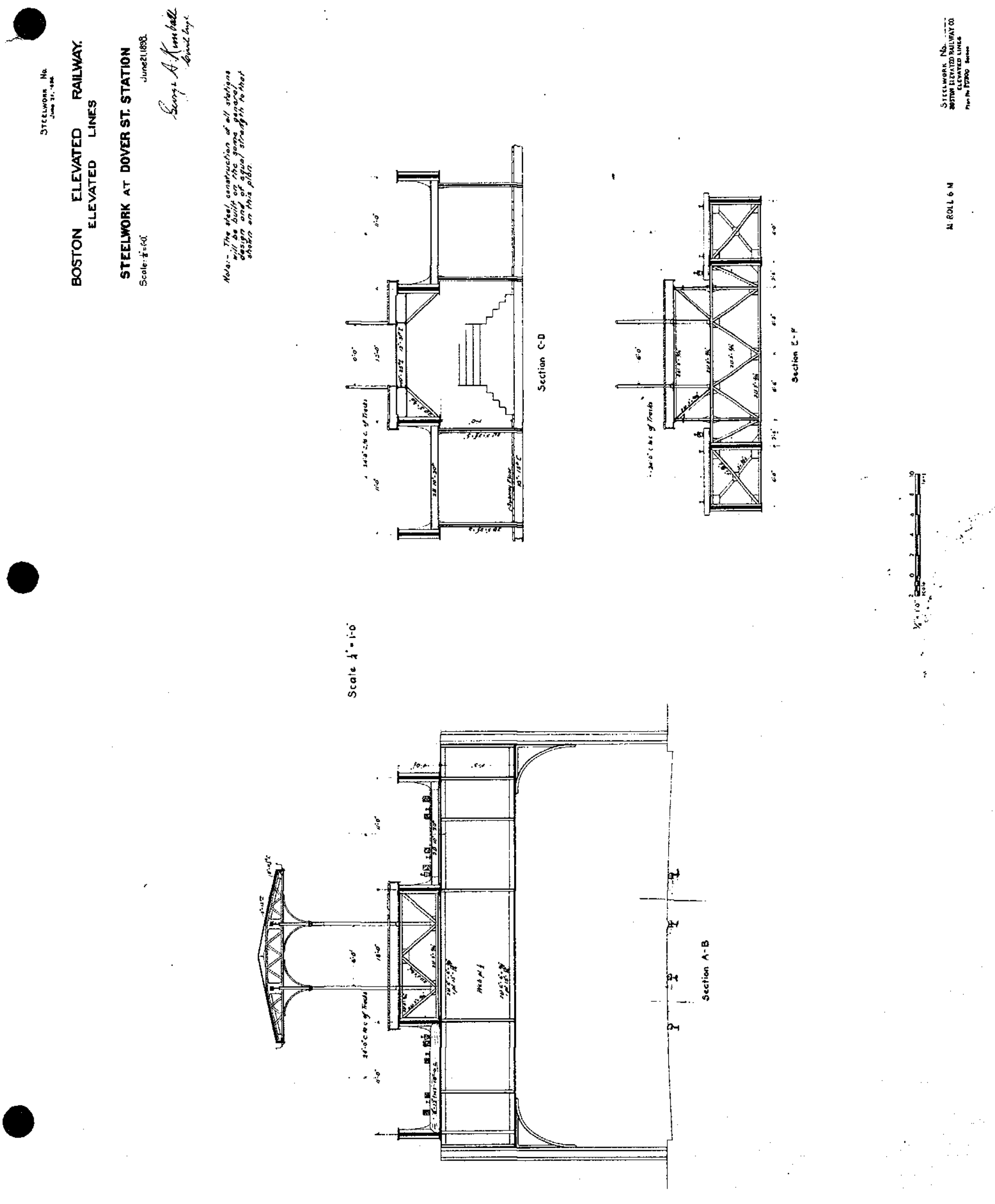
Boston Elevated Railway Company
HAER No. MA-14 HD-50
Page 269

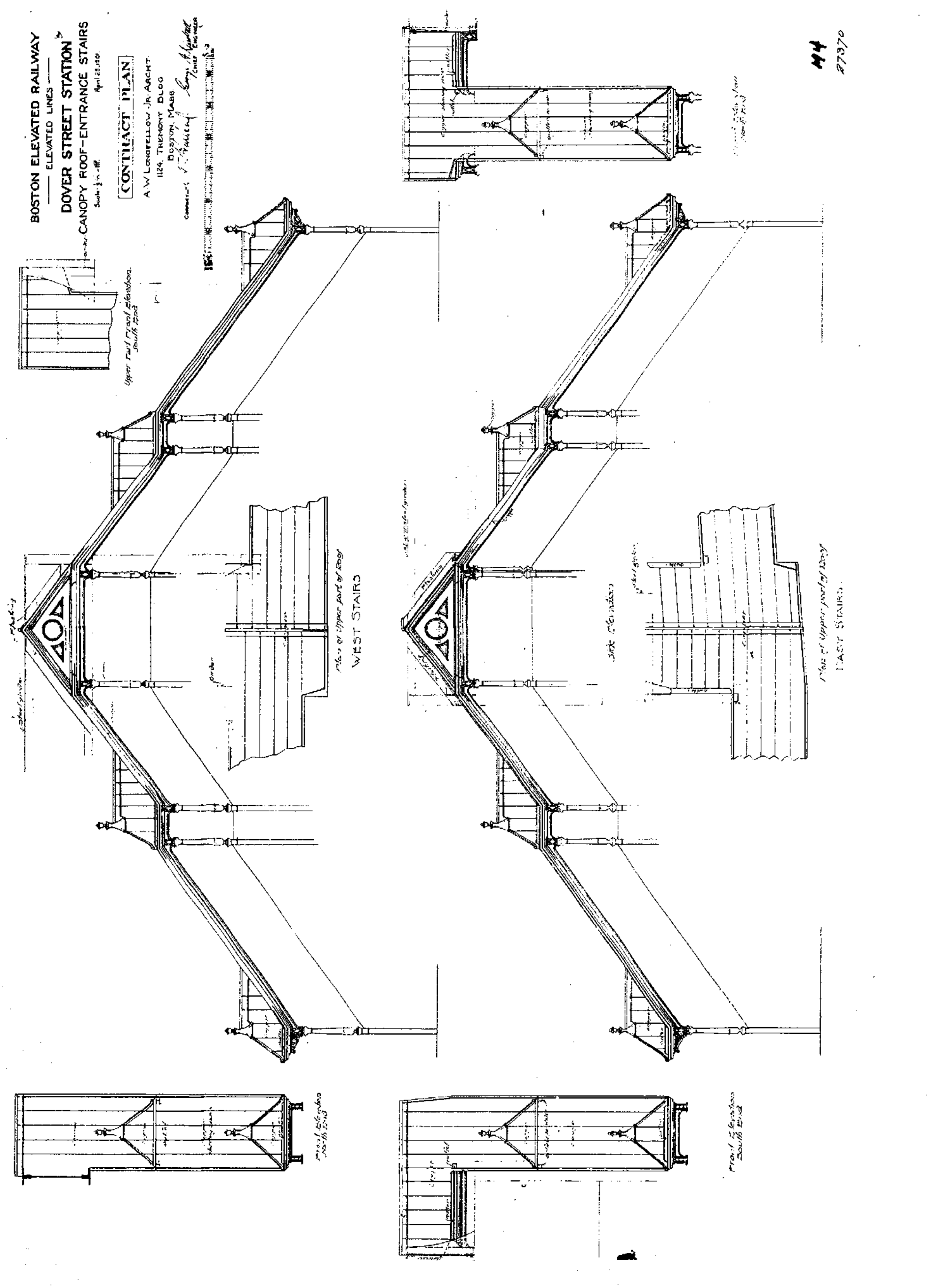



BOSTON ELEVATED RAILWAY
ELEVATED LINES
DOVER ST. STATION
Aug. 7 1900
CONTRACT PLAN
Vice President
Drawn by
Checked by
Correct
DOVER ST.
WASHINGTON ST.
SOUTH BOUND 'L'
NORTH BOUND 'L'
ELEVATED PLATFORM
WAITING ROOM
Ticket Office
ENTRANCE
EXIT
EAST ELEVATION
ELEVATED PLATFORM 42.46
BASE OF RAIL 38.50
DOVER ST.
21650

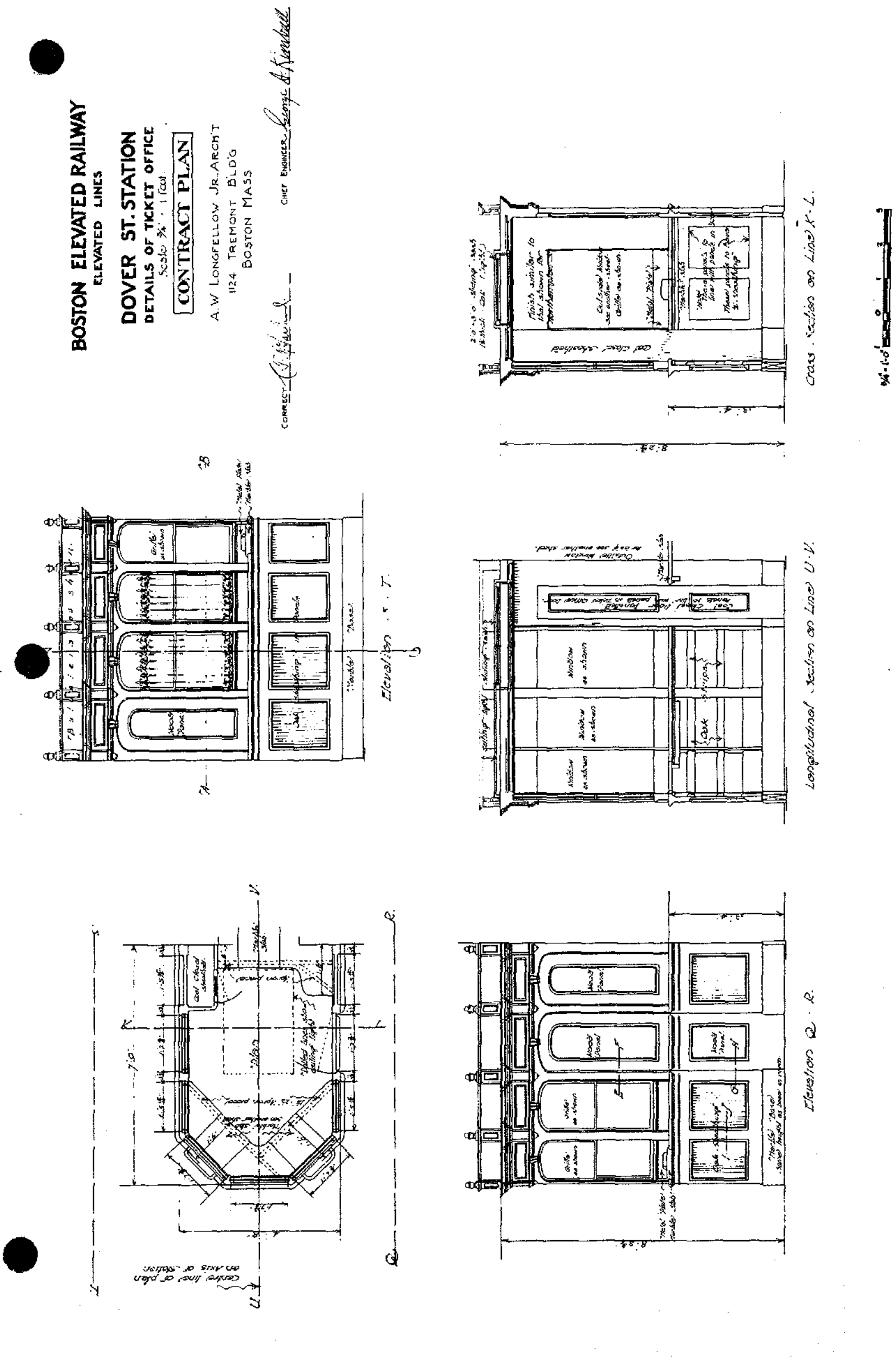

BOSTON ELEVATED RAILWAY
ELEVATED LINES
DOVER STREET STATION
SECTIONS
CONTRACT PLAN
A.W. LONGFELLOW JR., ARCH'T
1124 TREMONT BLDG
BOSTON MASS.
LONGITUDINAL SECTION
LOOKING SOUTH
LOOKING NORTH
½ CROSS SECTIONS

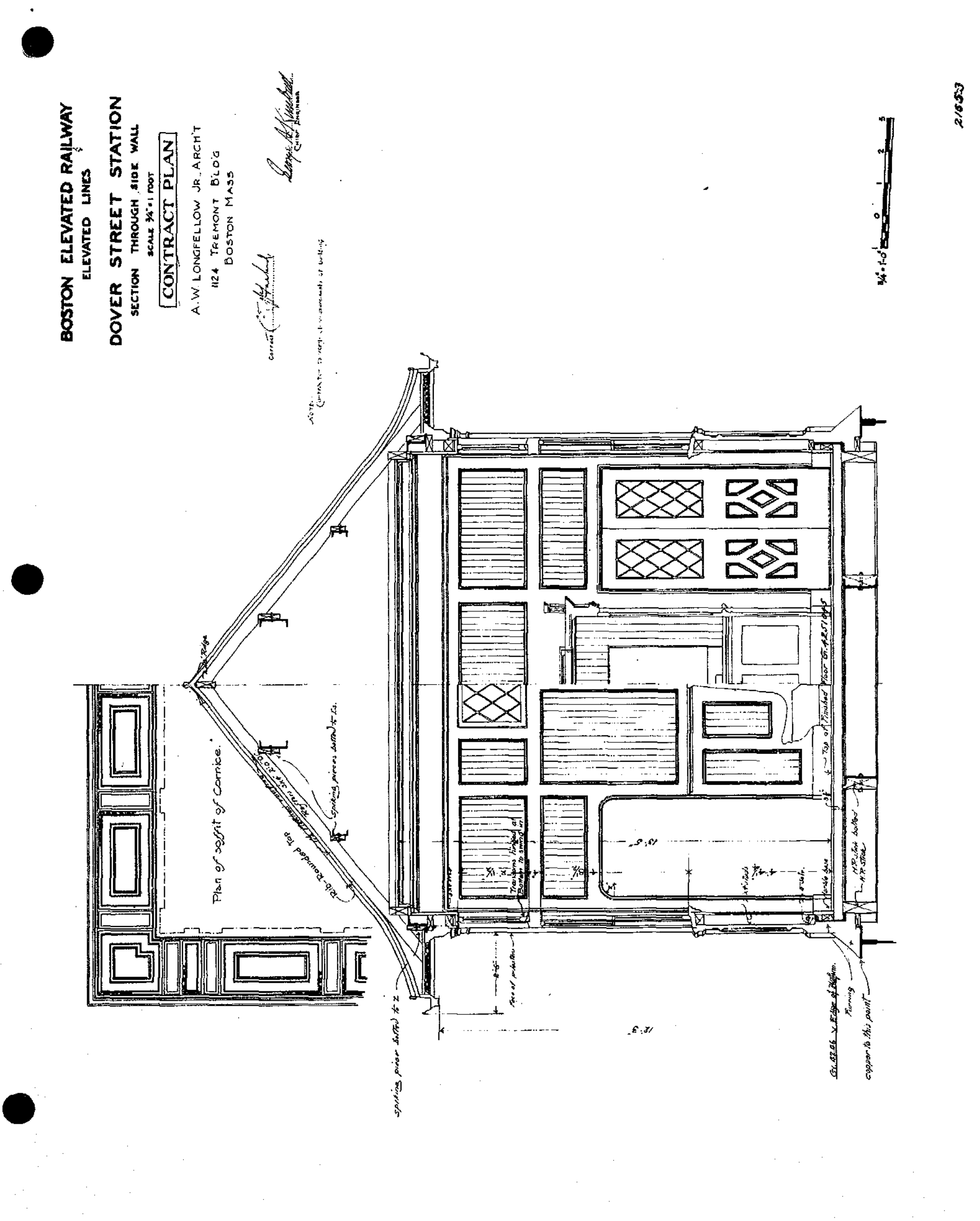

BOSTON ELEVATED RAILWAY
ELEVATED LINES
PLAN, CROSS SECTION AND ELEVATION OF STANDARD PLATFORM CANOPY
March 4 1899
TYPICAL DESIGN
CHIEF ENGINEER
Detail of Planking
ELEVATION
PLAN
CROSS SECTION
Top of Platform
Top of Rail


BOSTON ELEVATED RAILWAY.
ELEVATED LINES
STEELWORK AT DOVER ST. STATION
June 21 1898
Section C-D
Section E-F
Scale 1/4" = 1'-0"
Section A-B


BOSTON ELEVATED RAILWAY
ELEVATED LINES
DOVER STREET STATION
CANOPY ROOF-ENTRANCE STAIRS
April 25, 1901.
CONTRACT PLAN
A. W. LONGFELLOW JR. ARCHT.
1124, TREMONT BLDG
BOSTON, MASS.
CHIEF ENGINEER
Upper part Front elevation South End
WEST STAIRS
EAST STAIRS
Side elevation
Front Elevation South End
Front Elevation North End
27370

2/659


BOSTON ELEVATED RAILWAY
ELEVATED LINES
DOVER ST. STATION
DETAILS OF TICKET OFFICE
Scale 3/4" = 1 foot
CONTRACT PLAN
A.W. LONGFELLOW JR. ARCH'T
1124 TREMONT BLD'G
BOSTON MASS
CHIEF ENGINEER George A. Kimball
CORRECT
Elevation S-T
Cross Section on Line K-L
Longitudinal Section on Line U-V
Elevation Q-R
Plan

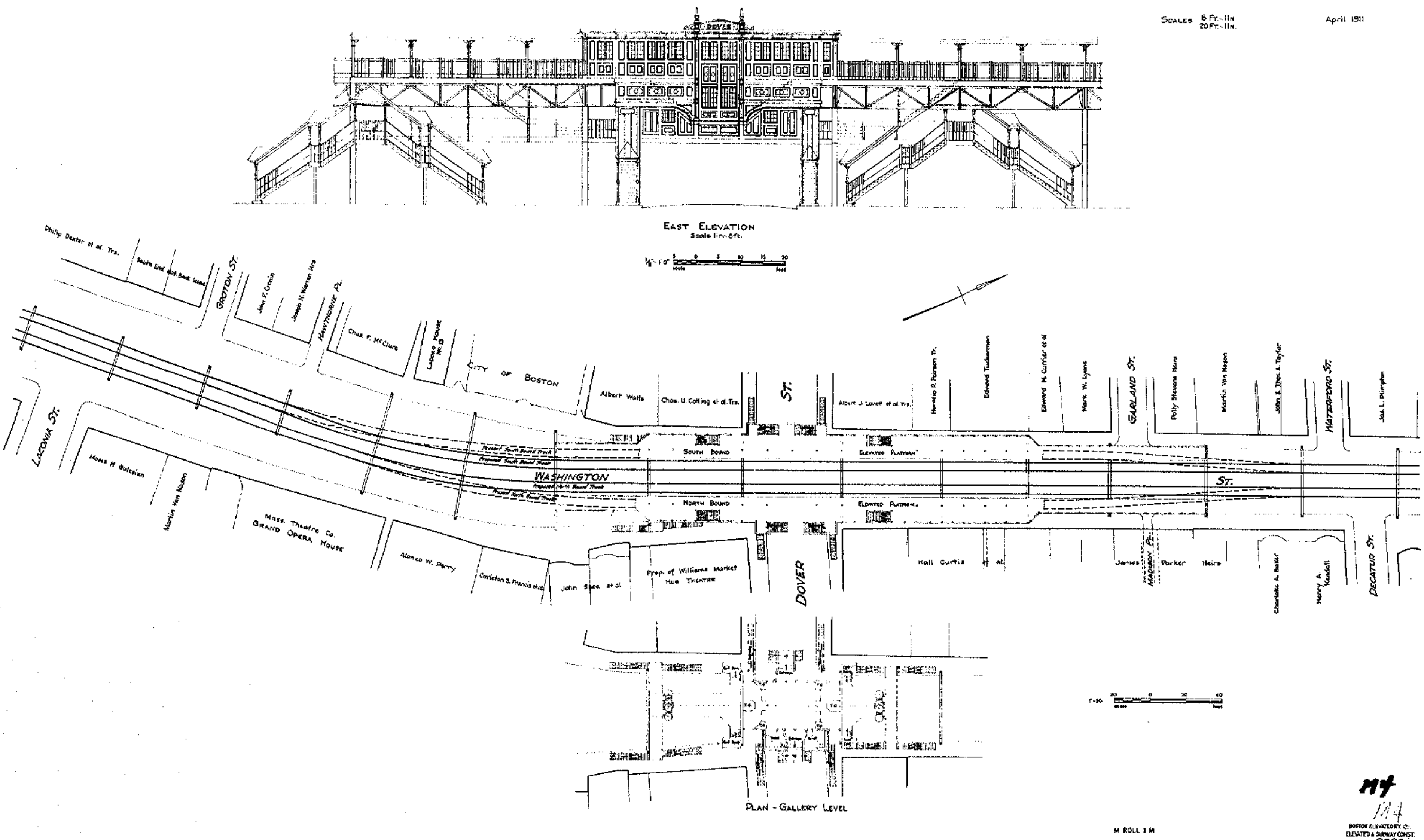

BOSTON ELEVATED RAILWAY
ELEVATED LINES
DOVER STREET STATION
SECTION THROUGH SIDE WALL
SCALE 3/4"=1 FOOT
CONTRACT PLAN
A.W. LONGFELLOW JR. ARCH'T
1124 TREMONT BLD'G
BOSTON MASS
Plan of soffit of Cornice.
Rib-Rounded top
Ridge
Top of Finished Floor
copper to this point
21653

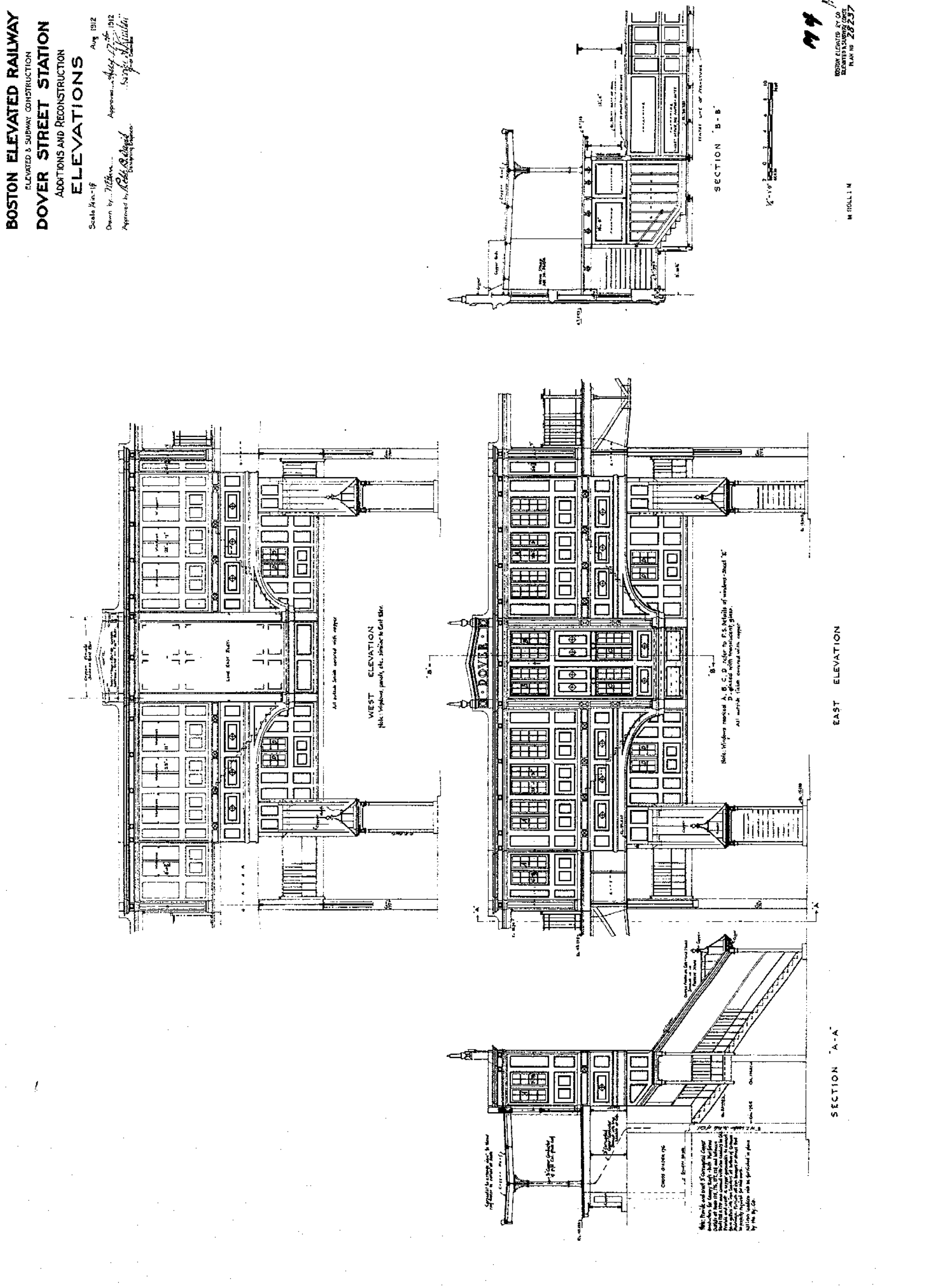
BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION

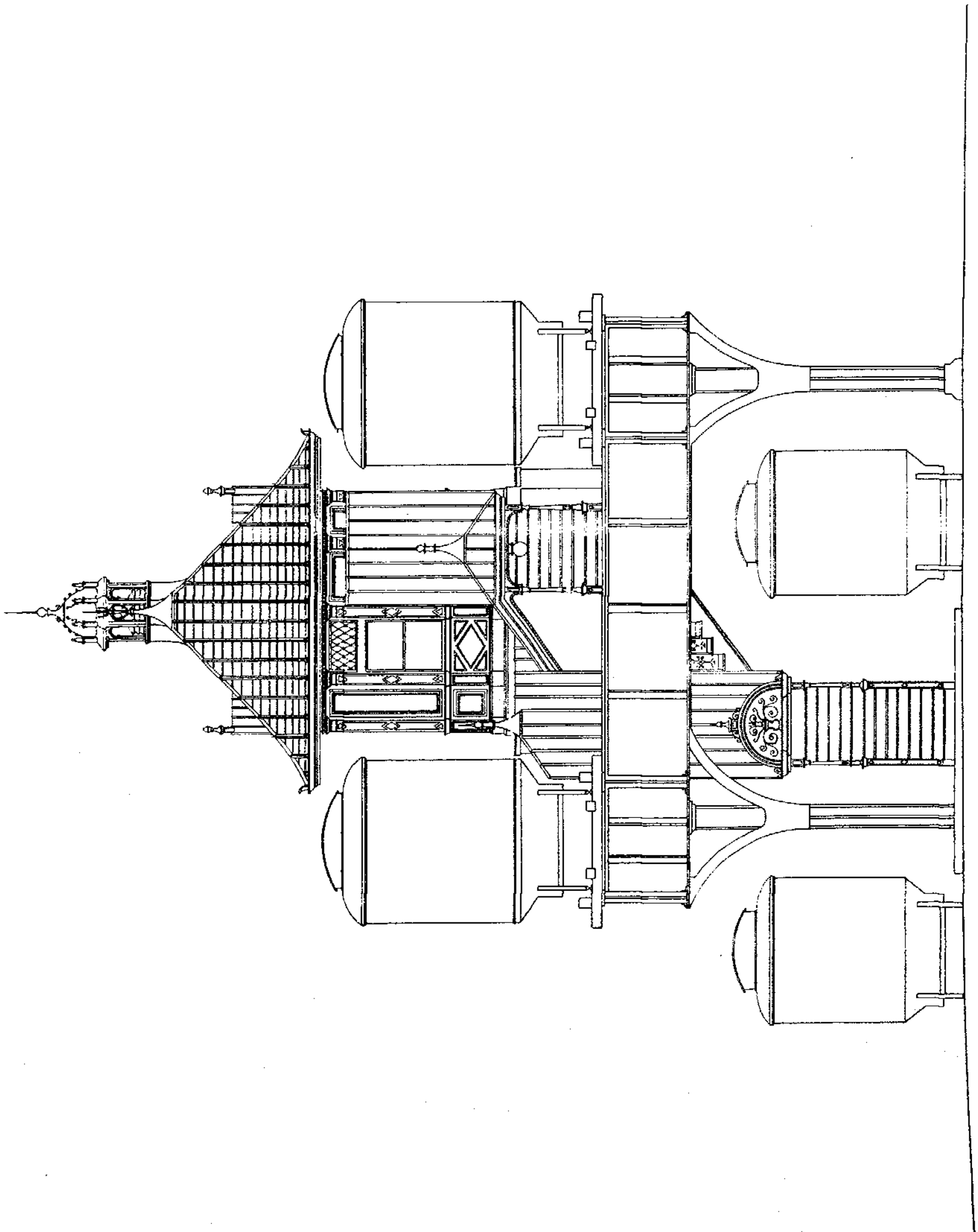
DOVER STREET STATION

MODIFICATIONS AND CHANGES
FOR
EIGHT CAR TRAINS

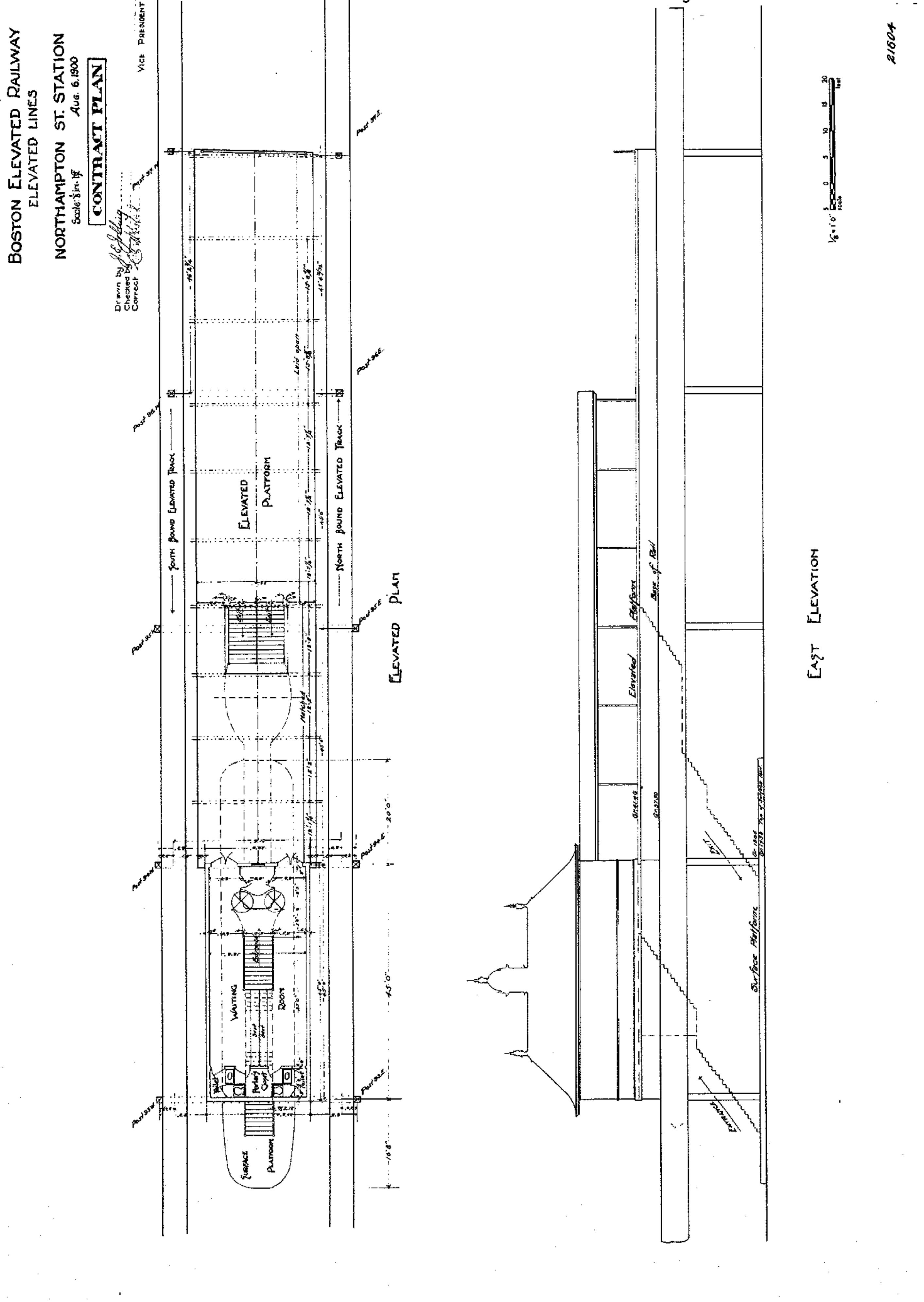
SCALES 8 FT.-1 IN. 20 FT.-1 IN.   April 1911

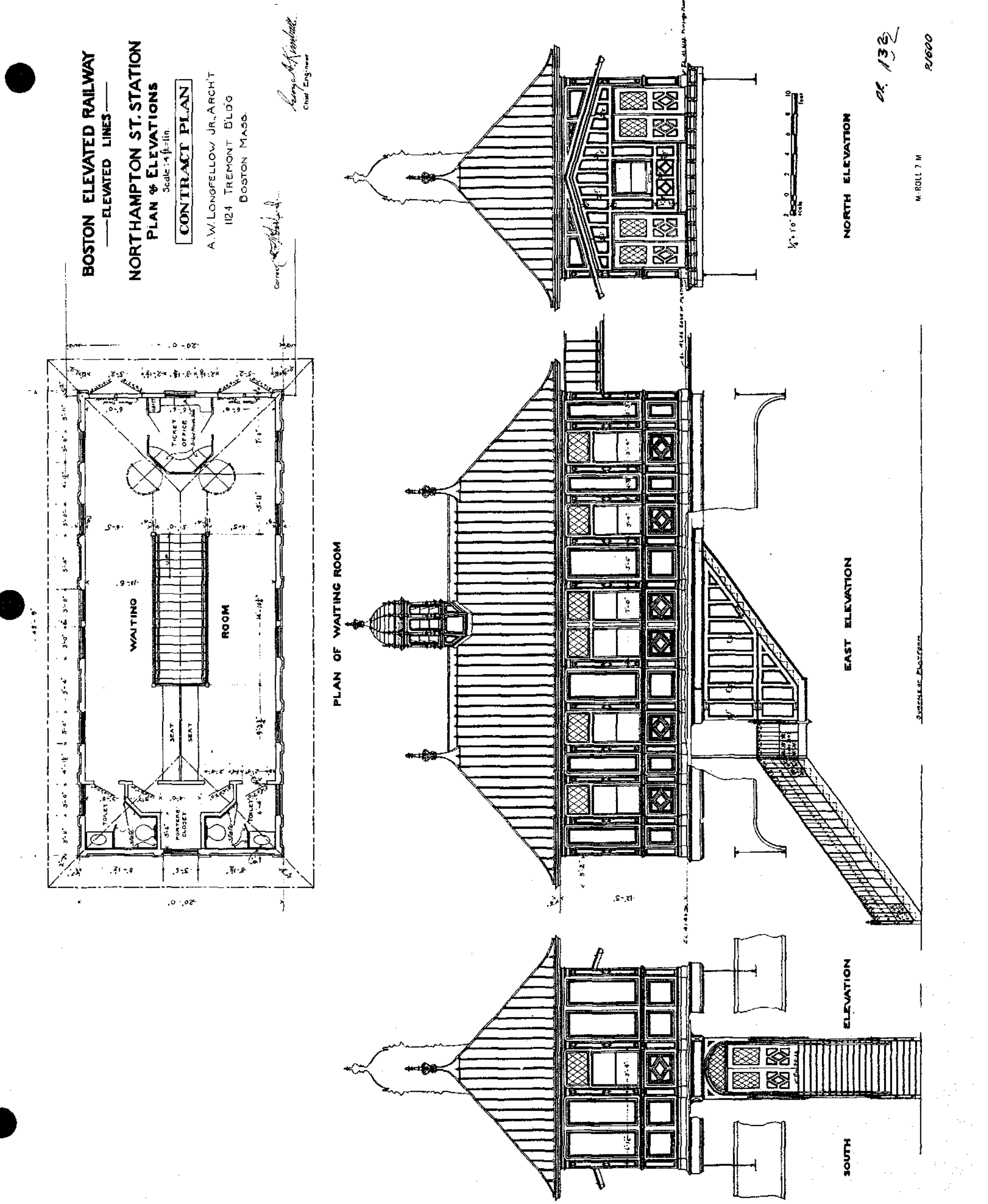


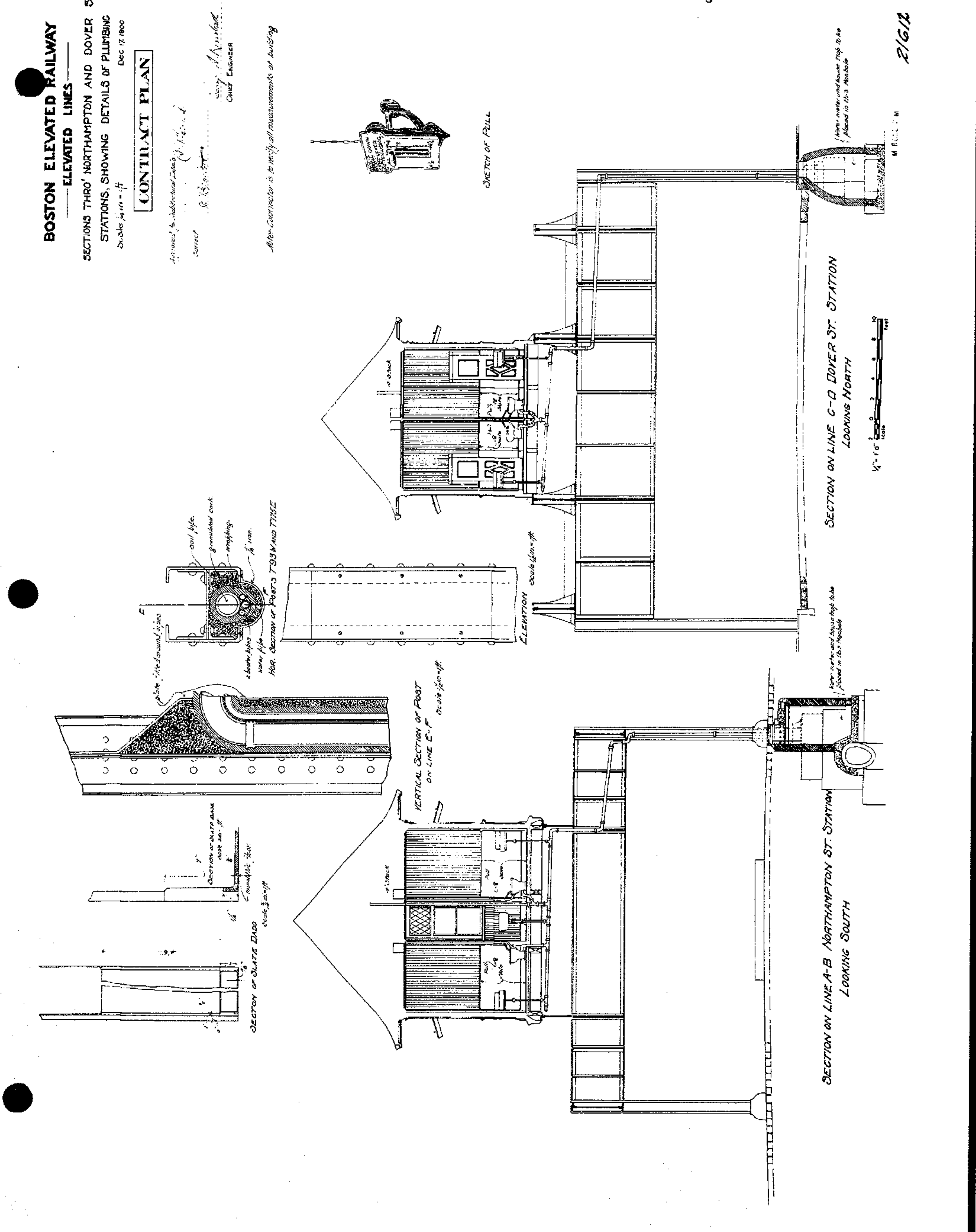

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
DOVER STREET STATION
ADDITIONS AND RECONSTRUCTION
ELEVATIONS
SECTION 'B-B'
WEST ELEVATION
DOVER
EAST ELEVATION
SECTION 'A-A'

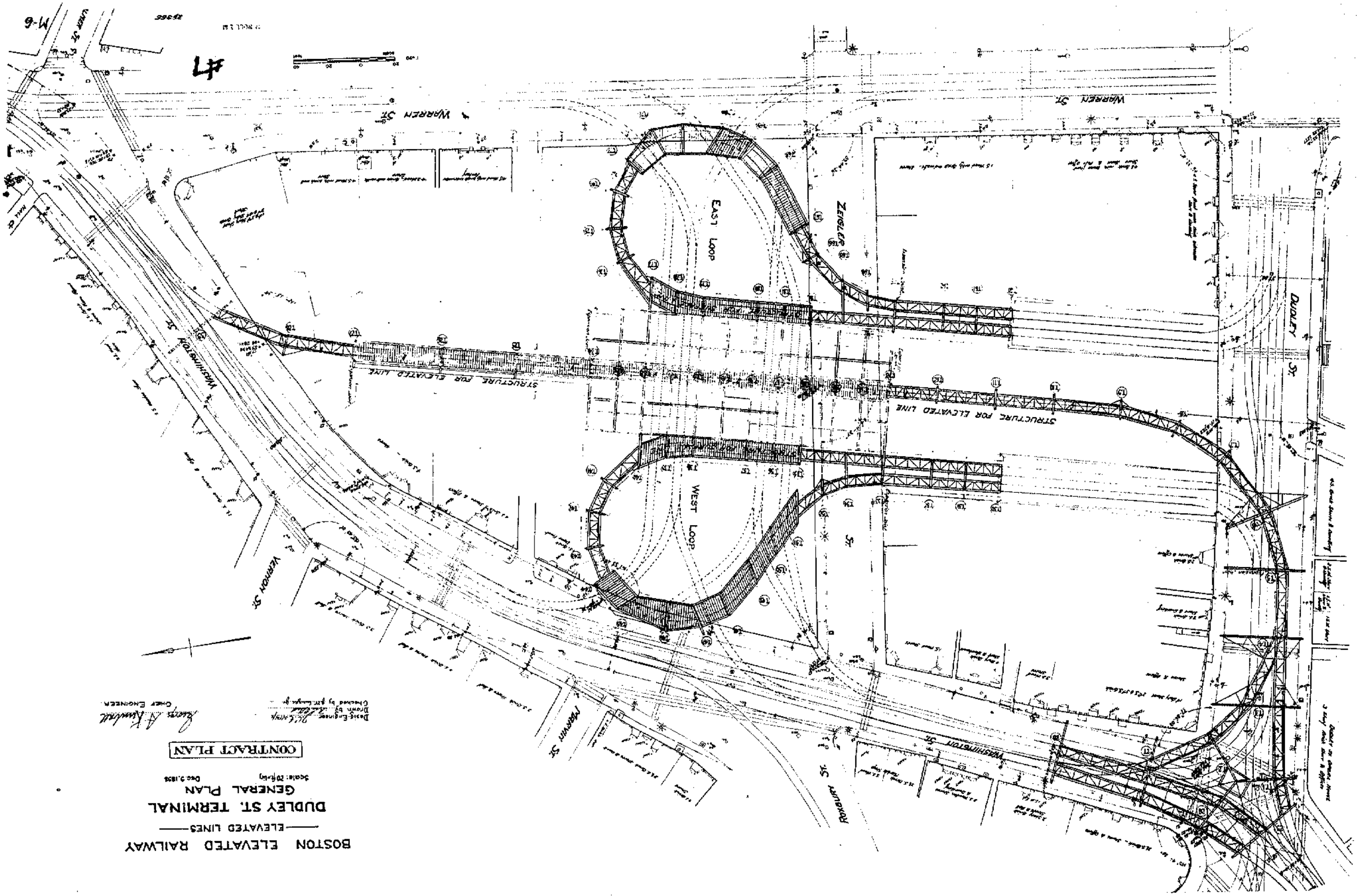


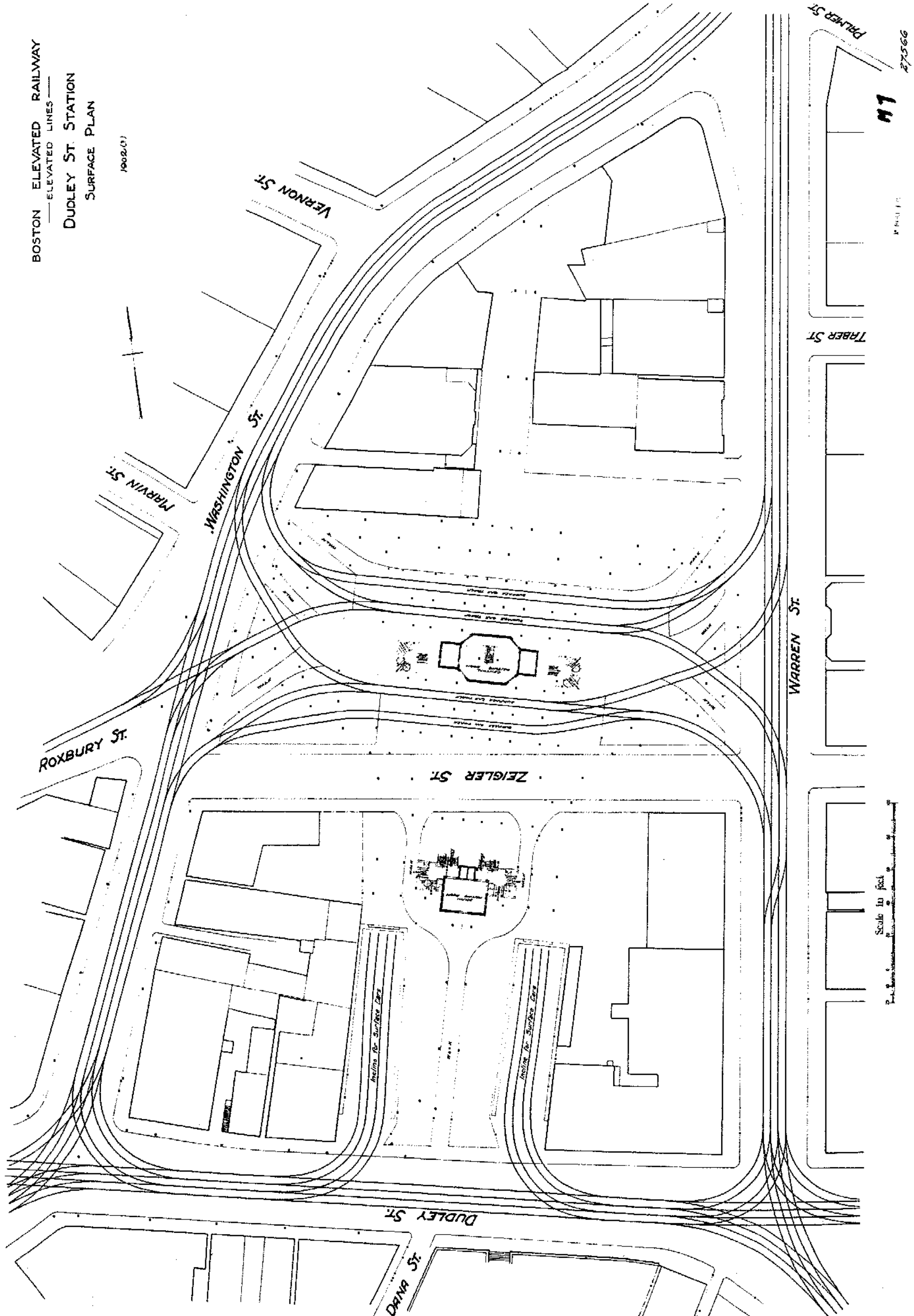
Section through Typical Island Station

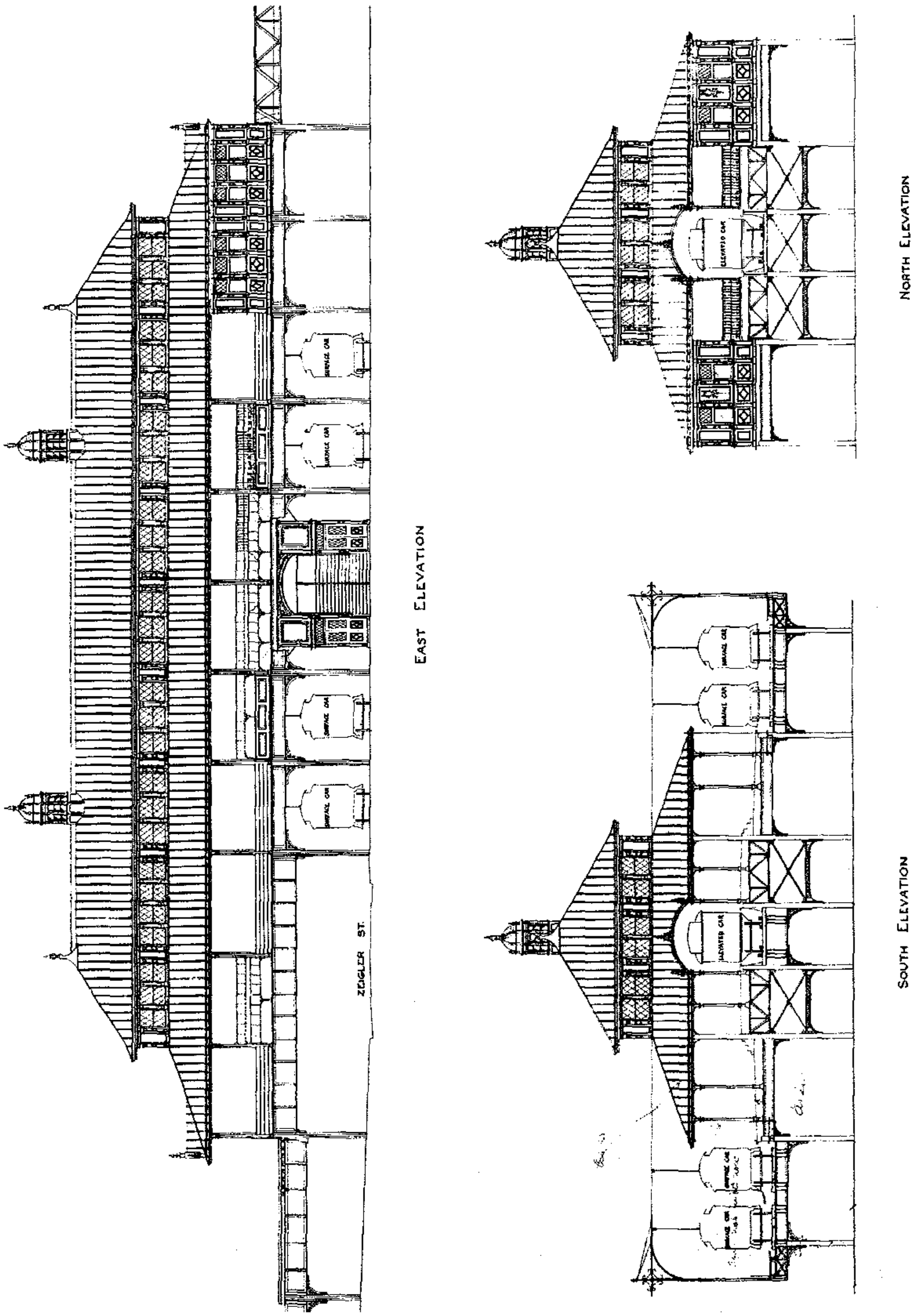

Station No 3 Sheet
Boston Elevated Railway
Elevated Lines
Northampton St. Station
Scale 1/8 in.=1 ft
Aug. 6, 1900
Contract Plan
Drawn by
Checked by
Correct
Vice President
South Bound Elevated Track
North Bound Elevated Track
Elevated Platform
Waiting Room
Surface Platform
Elevated Plan
Elevated Platform
Base of Rail
Surface Platform
Exit
Entrance
East Elevation
21604

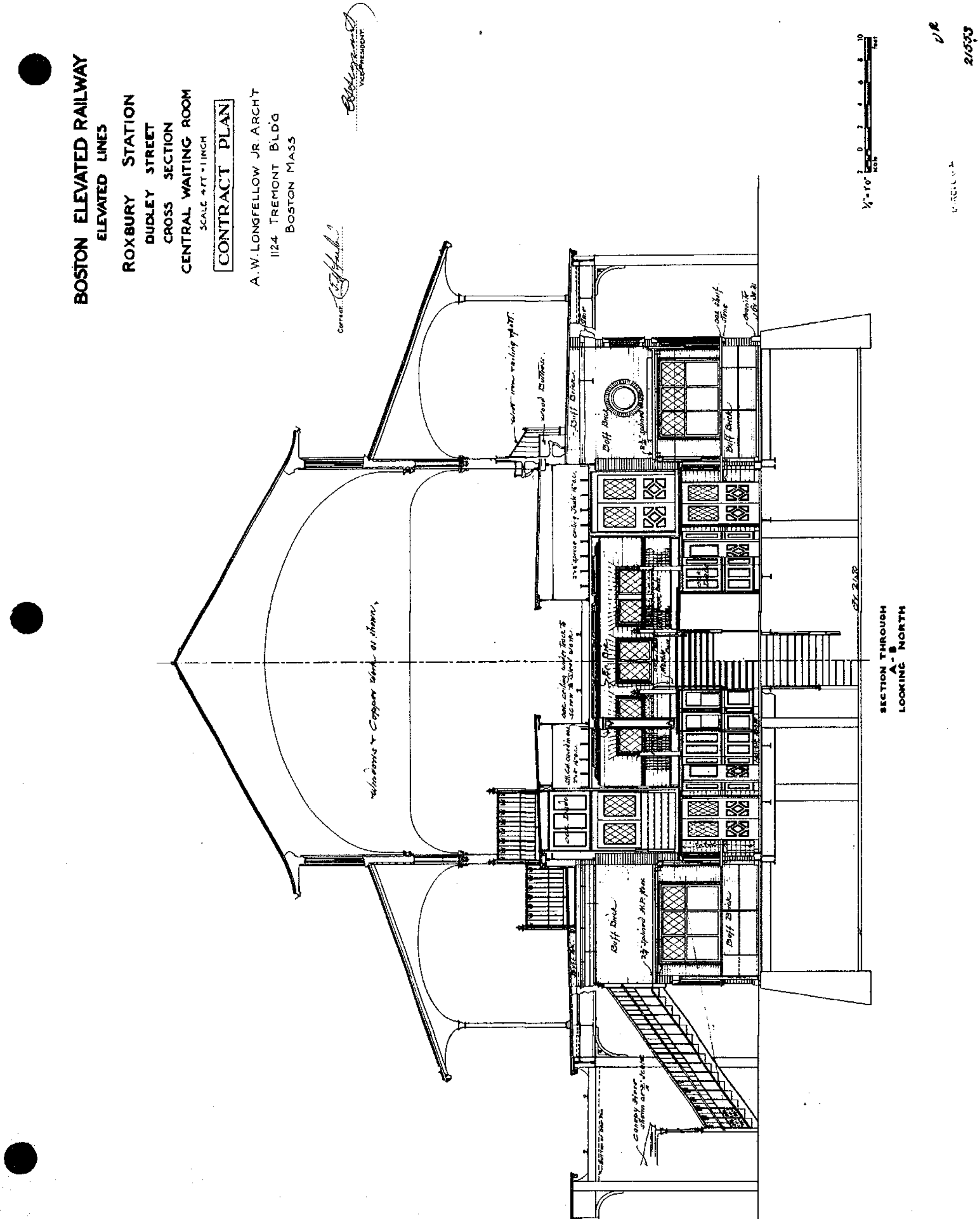

BOSTON ELEVATED RAILWAY
—ELEVATED LINES—
NORTHAMPTON ST. STATION
PLAN & ELEVATIONS
CONTRACT PLAN
A.W. LONGFELLOW JR., ARCH'T
1124 TREMONT B'LD'G
BOSTON MASS.
PLAN OF WAITING ROOM
WAITING
ROOM
TICKET OFFICE
SEAT
SEAT
PORTERS CLOSET
TOILET
TOILET
NORTH ELEVATION
EAST ELEVATION
SOUTH ELEVATION
M-ROLL 7 M
9/600

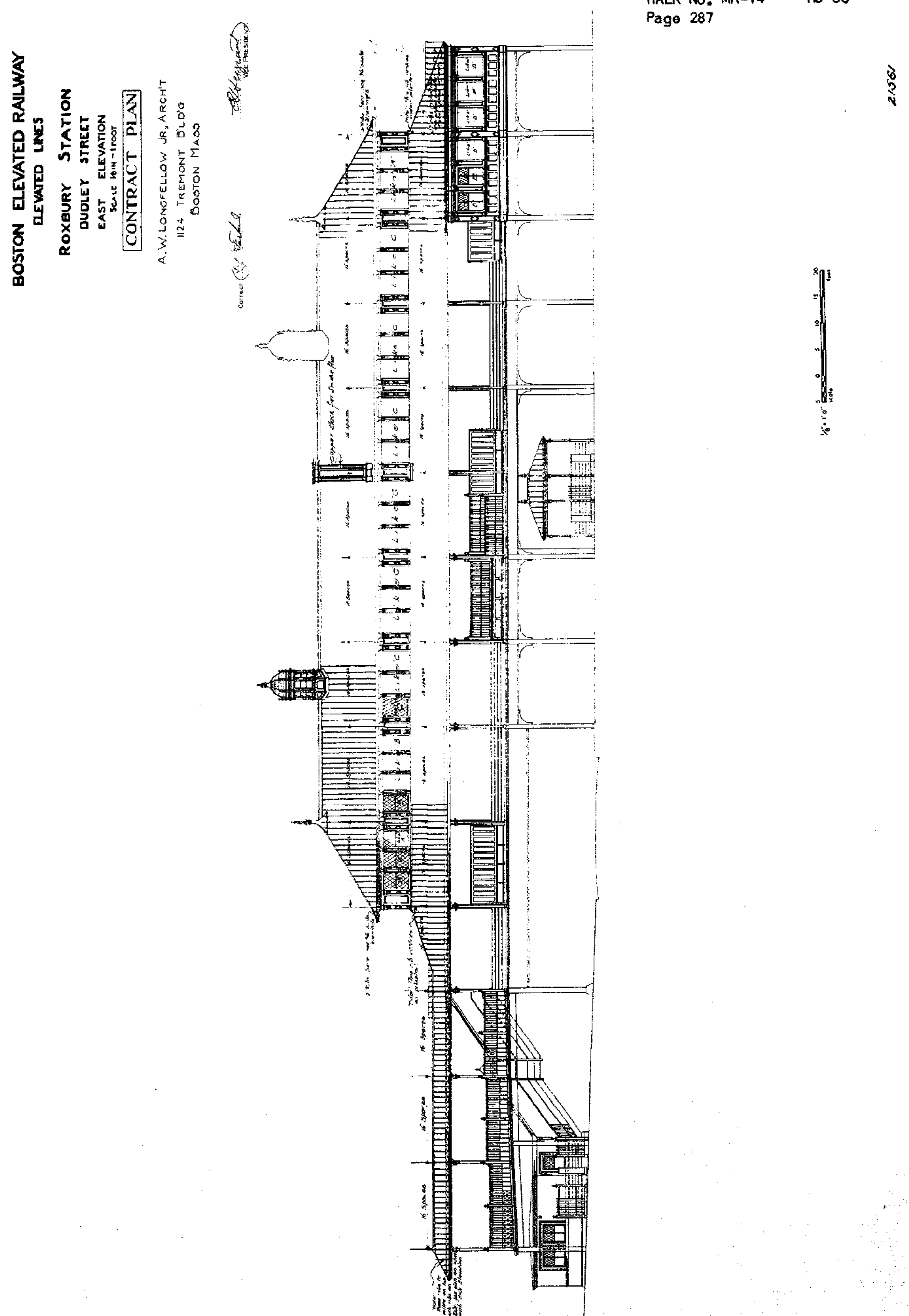

BOSTON ELEVATED RAILWAY
ELEVATED LINES
SECTIONS THRO' NORTHAMPTON AND DOVER ST. STATIONS, SHOWING DETAILS OF PLUMBING
Dec 17 1900
CONTRACT PLAN
CHIEF ENGINEER
Note: Contractor is to verify all measurements of building
SKETCH OF PULL
2/612
SECTION ON LINE C-D DOVER ST. STATION
LOOKING NORTH
SECTION ON LINE A-B NORTHAMPTON ST. STATION
LOOKING SOUTH
VERTICAL SECTION OF POST ON LINE E-F
ELEVATION
HOR. SECTION OF POSTS 793 W AND 793 E
Soil pipe
granulated cork
wrapping
SECTION OF SLATE DADO

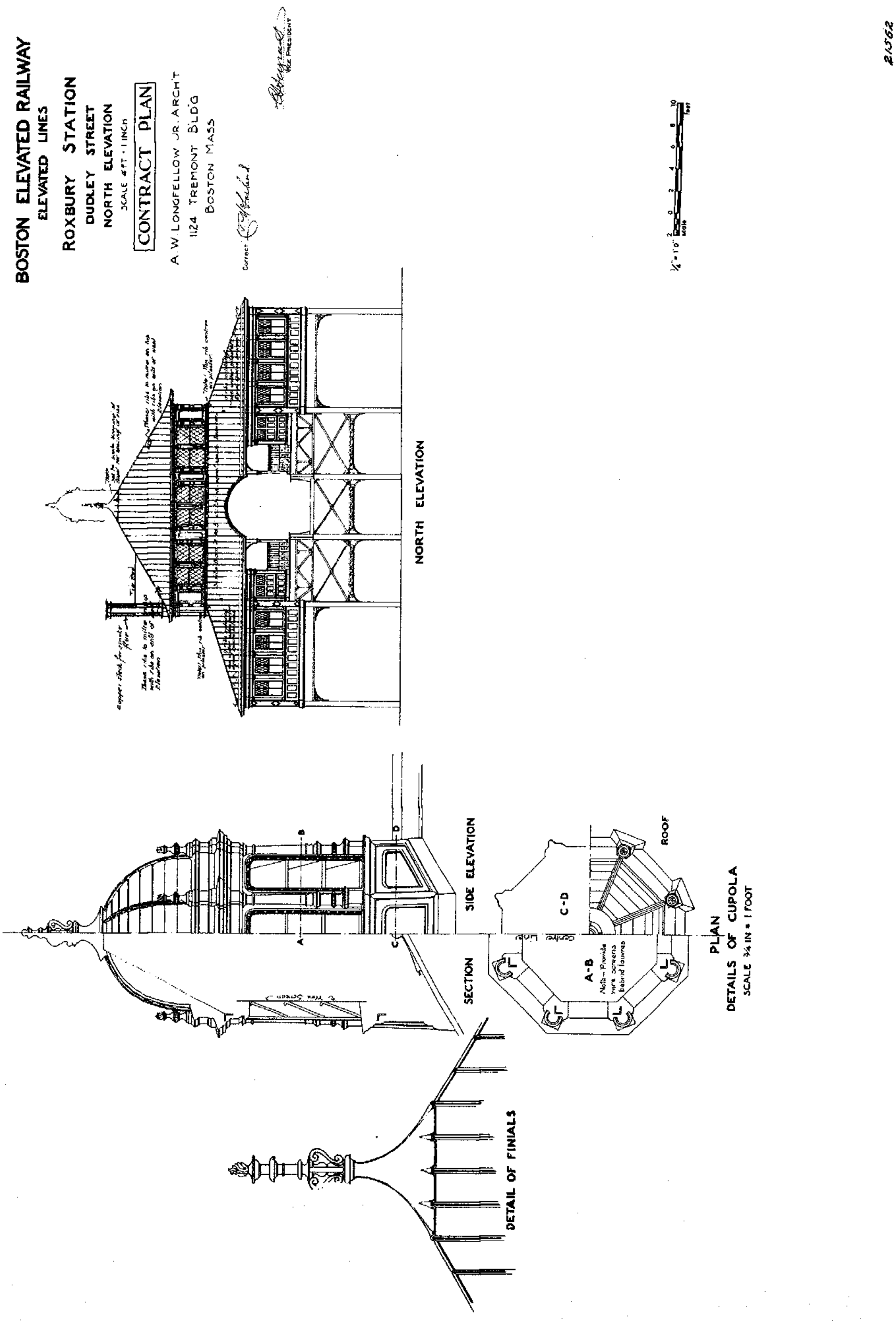

BOSTON ELEVATED RAILWAY
ELEVATED LINES
DUDLEY ST. TERMINAL
GENERAL PLAN
CONTRACT PLAN
CHIEF ENGINEER
WARREN ST.
WASHINGTON ST.
DUDLEY ST.
ZEIGLER
EAST LOOP
WEST LOOP
STRUCTURE FOR ELEVATED LINE
VERNON ST.
MARVIN ST.
ROXBURY ST.
M-6
LF

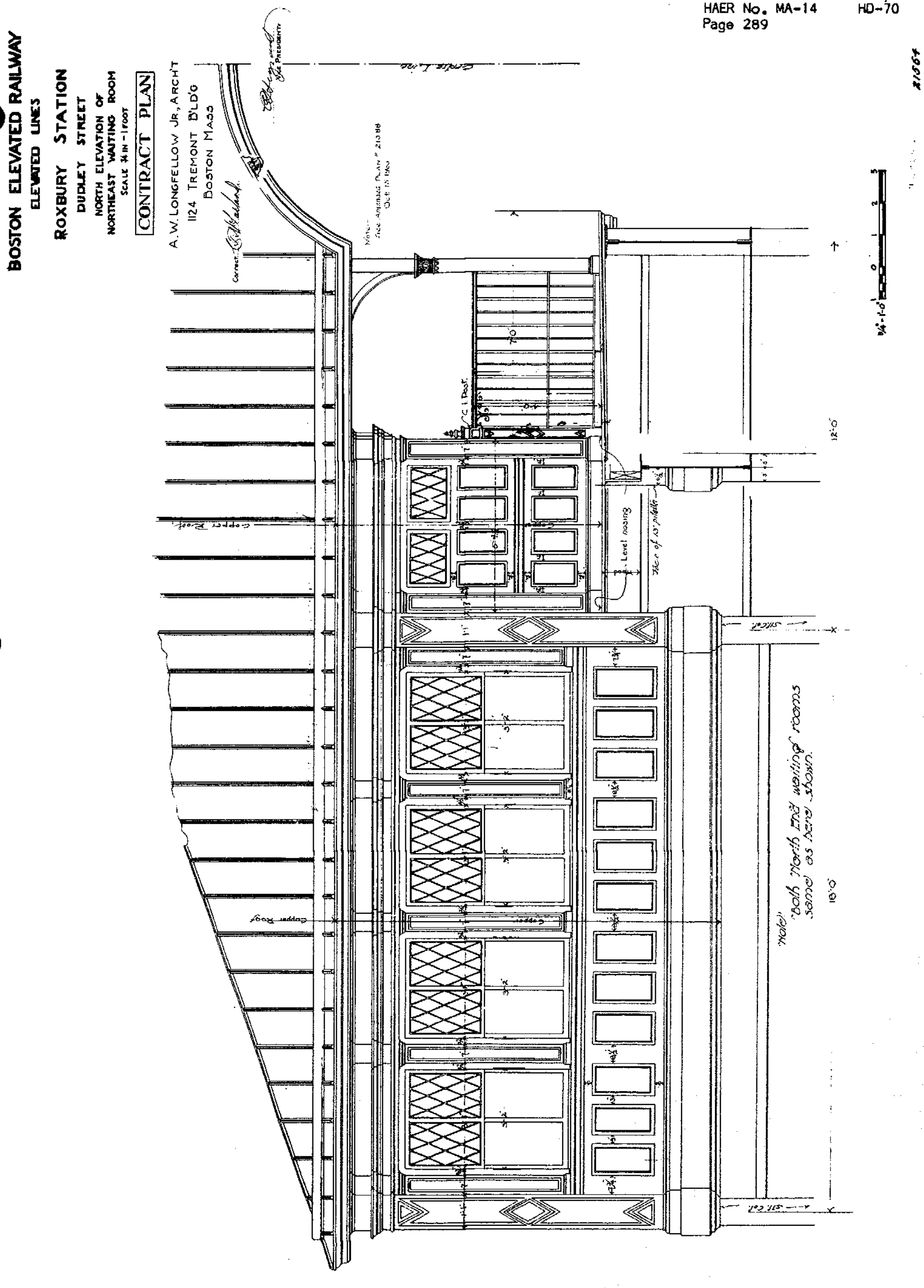

BOSTON ELEVATED RAILWAY
— ELEVATED LINES —
DUDLEY ST. STATION
SURFACE PLAN
VERNON ST.
WASHINGTON ST.
MARVIN ST.
ROXBURY ST.
ZEIGLER ST.
DUDLEY ST.
DANA ST.
WARREN ST.
TABER ST.
PALMER ST.
Incline for Surface Cars
Incline for Surface Cars
Scale in feet
M1
27566

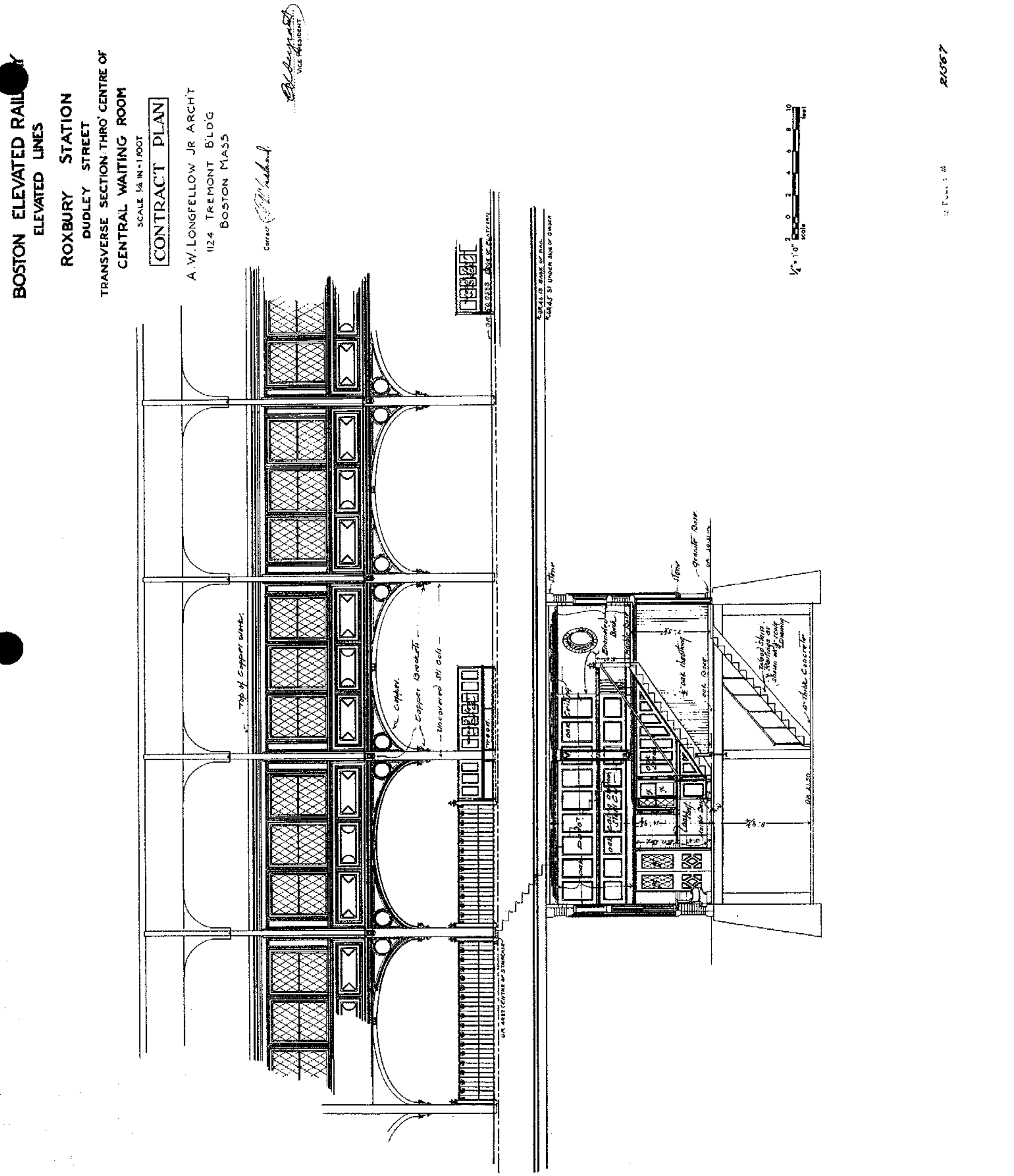

East Elevation
Zeigler St.
Surface Car
North Elevation
Elevated Car
South Elevation


BOSTON ELEVATED RAILWAY
ELEVATED LINES
ROXBURY STATION
DUDLEY STREET
CROSS SECTION
CENTRAL WAITING ROOM
CONTRACT PLAN
A. W. LONGFELLOW JR. ARCH'T
1124 TREMONT BLDG
BOSTON MASS
VICE PRESIDENT
Correct
SECTION THROUGH
A-B
LOOKING NORTH
Buff Brick
wood Buttress
Wroughts & Copper Work as shown
21553


BOSTON ELEVATED RAILWAY
ELEVATED LINES
ROXBURY STATION
DUDLEY STREET
EAST ELEVATION
SCALE 1/8 IN = 1 FOOT
CONTRACT PLAN
A.W. LONGFELLOW JR, ARCH'T
1124 TREMONT B'LD'G
BOSTON MASS
21561


BOSTON ELEVATED RAILWAY
ELEVATED LINES
ROXBURY STATION
DUDLEY STREET
NORTH ELEVATION
SCALE 4 FT = 1 INCH
CONTRACT PLAN
A. W. LONGFELLOW JR. ARCH'T
1124 TREMONT BLD'G
BOSTON MASS
VICE PRESIDENT
21562
NORTH ELEVATION
SIDE ELEVATION
SECTION
ROOF
C-D
A-B
PLAN
DETAILS OF CUPOLA
SCALE 3/4 IN = 1 FOOT
DETAIL OF FINIALS

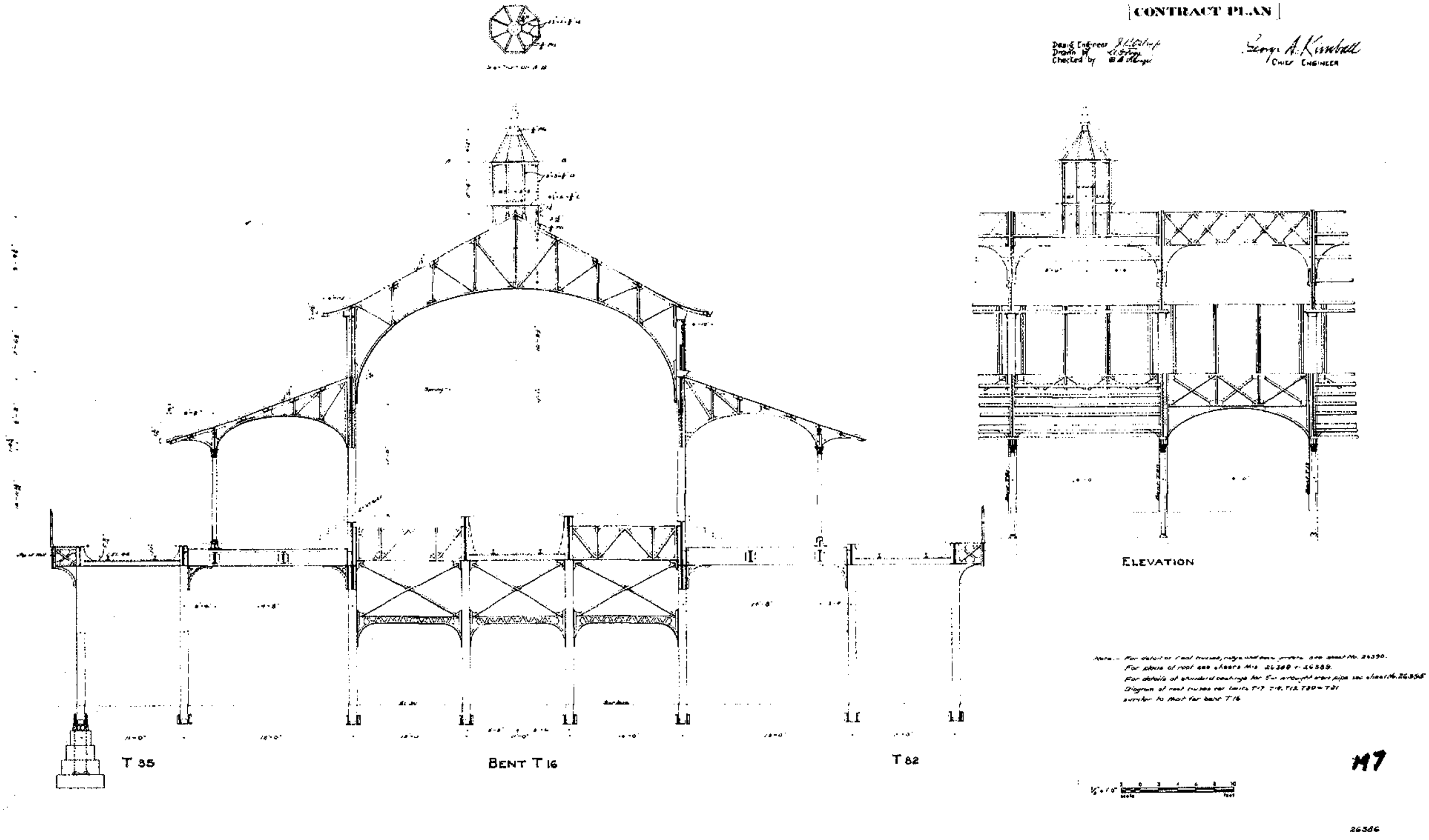

BOSTON ELEVATED RAILWAY
ELEVATED LINES
ROXBURY STATION
DUDLEY STREET
NORTH ELEVATION OF
NORTHEAST WAITING ROOM
SCALE 3/4 IN - 1 FOOT
CONTRACT PLAN
A. W. LONGFELLOW JR, ARCH'T
1124 TREMONT B'LD'G
BOSTON MASS
Copper Roof
Copper Roof
Level nosing
Note:
Both North End waiting rooms
same as here shown.
12'0"
16'0"
21564


BOSTON ELEVATED RAILWAY
ELEVATED LINES
ROXBURY STATION
DUDLEY STREET
TRANSVERSE SECTION THRO' CENTRE OF
CENTRAL WAITING ROOM
SCALE 1/4 IN = 1 FOOT
CONTRACT PLAN
A.W. LONGFELLOW JR ARCH'T
1124 TREMONT B'LD'G
BOSTON MASS
VICE PRESIDENT
Top of Copper Work
Copper
Copper Brackets
Uncovered St. Cols
oak Ceiling
oak Base
Granite Base
21567

BOSTON ELEVATED RAILWAY
ELEVATED LINES
DUDLEY ST. TERMINAL
CROSS SECTION OF BUILDING AT BENT T16
March 13 1898.

CONTRACT PLAN

Chief Engineer

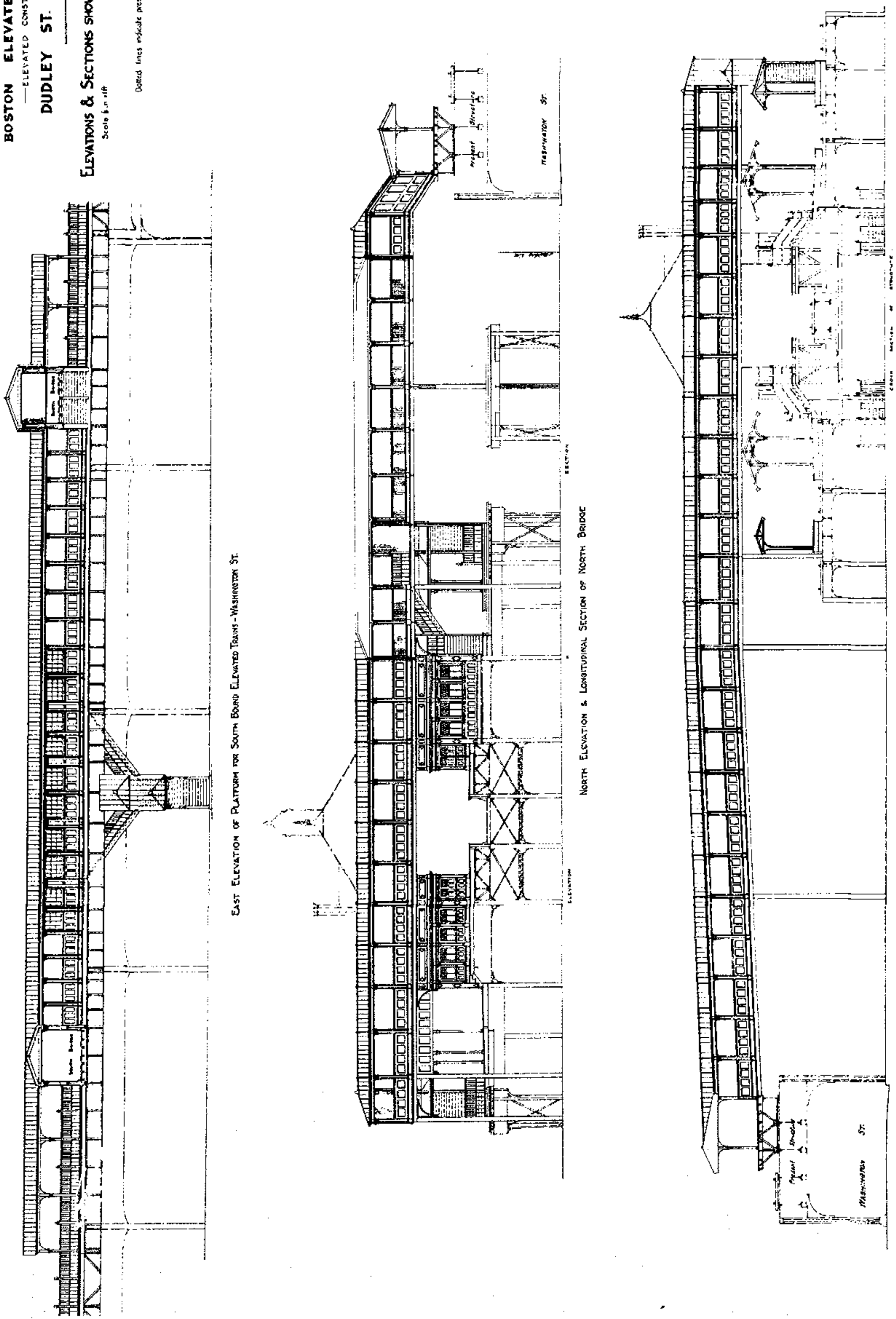


M6
27580

BOSTON ELEVATED RAILWAY
—ELEVATED CONSTRUCTION—
DUDLEY ST. STATION

ELEVATIONS & SECTIONS SHOWING PROPOSED CHANGES
Scale 1/8 in = 1 ft
December 1906

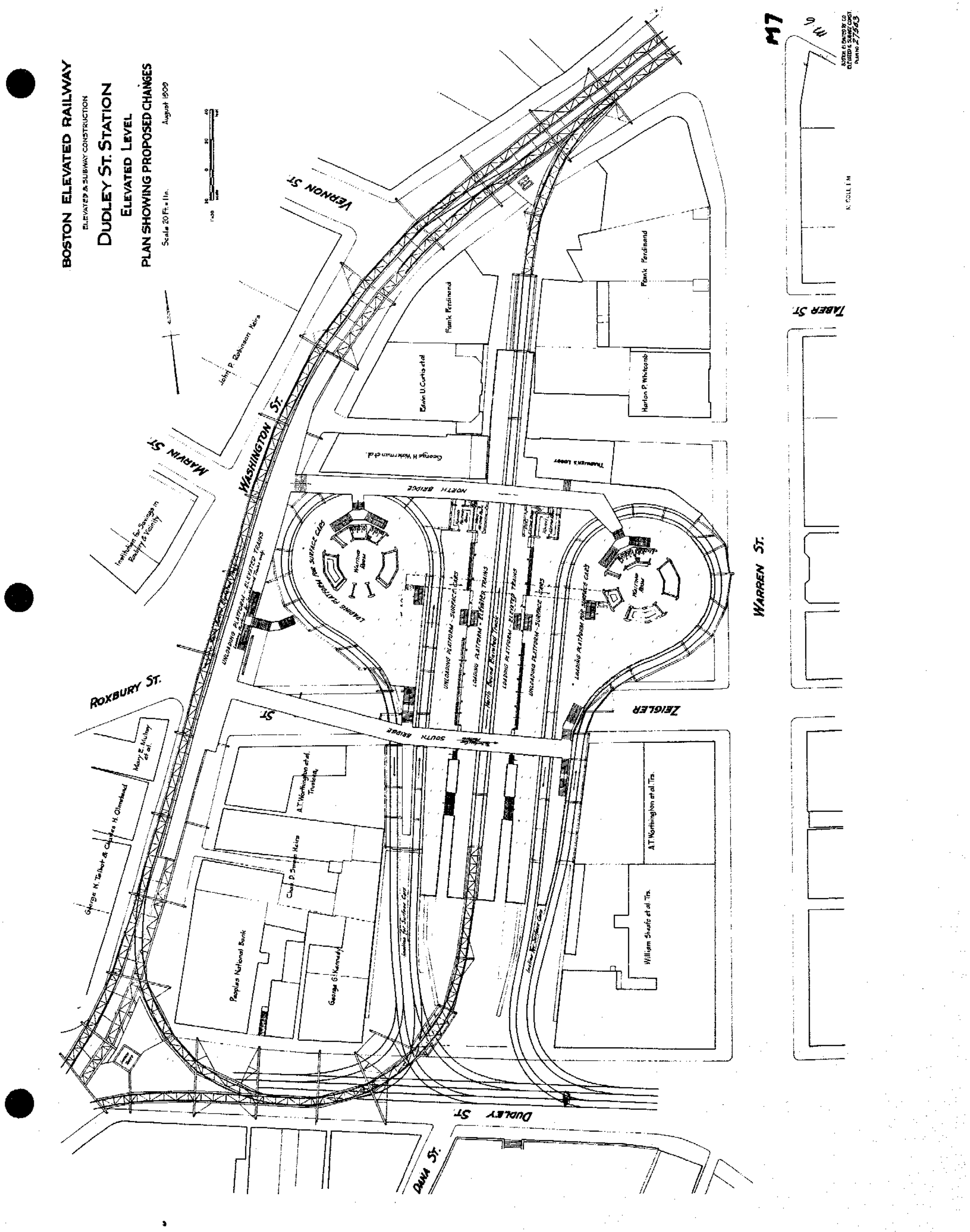
Dotted lines indicate present structure

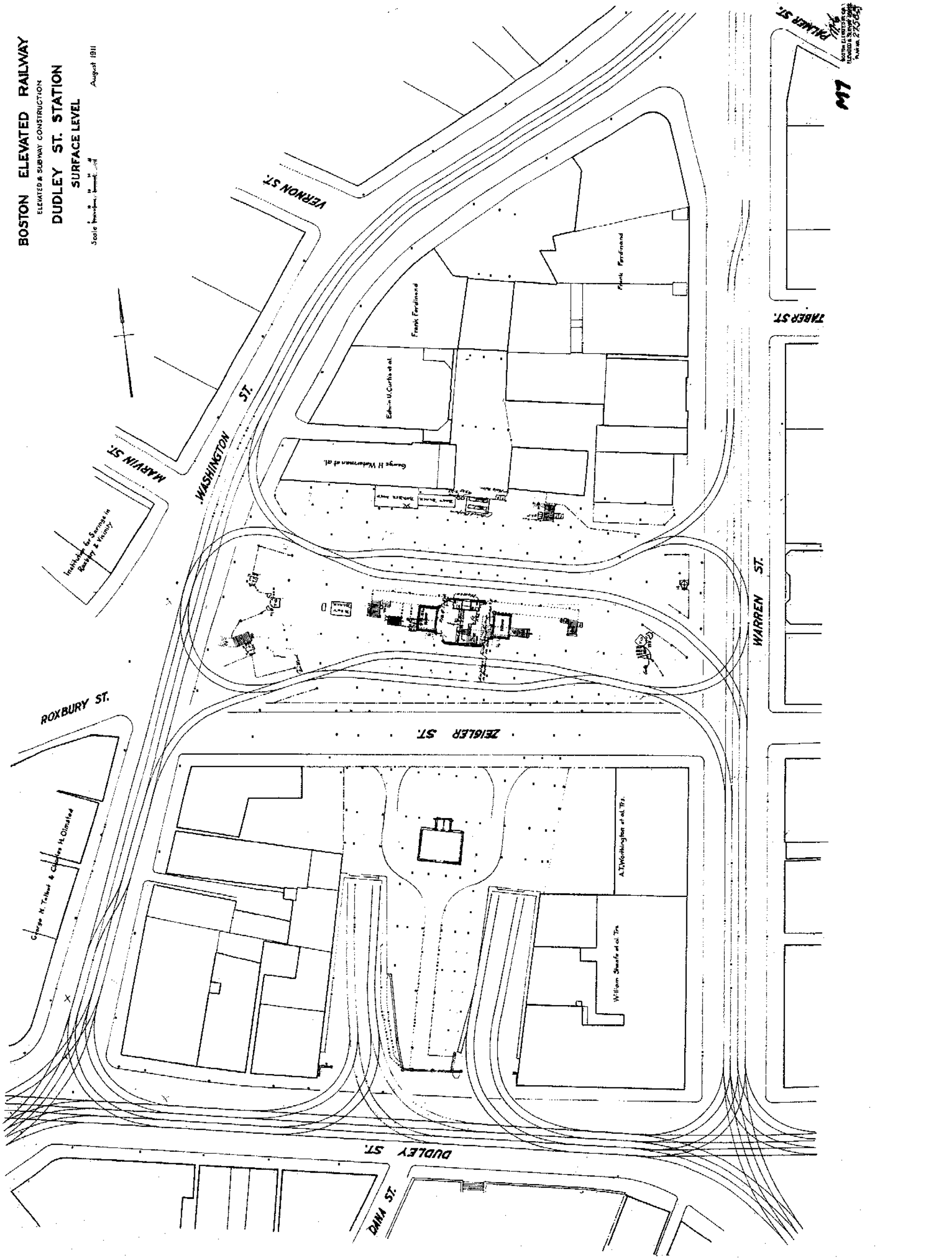


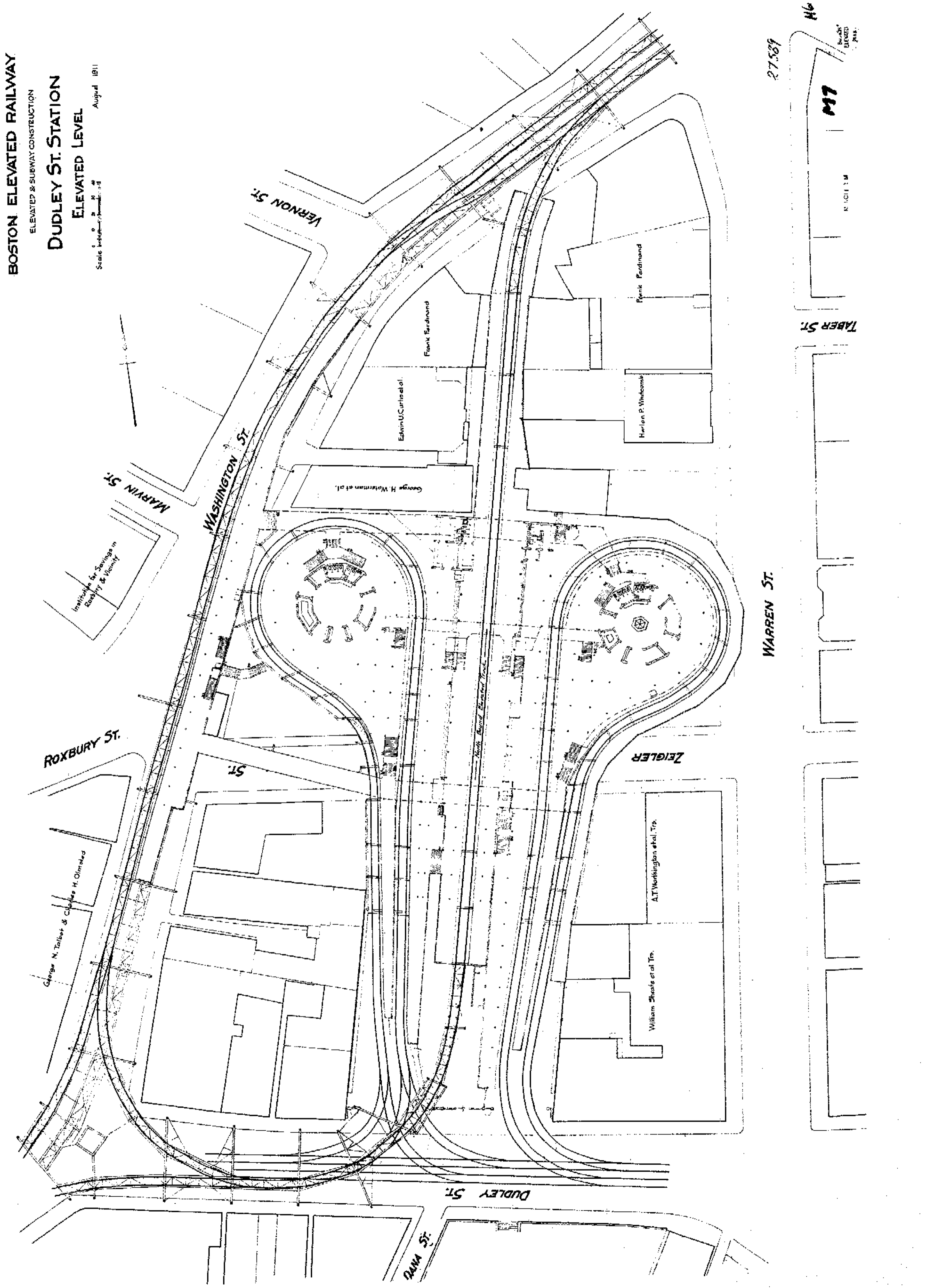
East Elevation of Platform for South Bound Elevated Trains - Washington St.

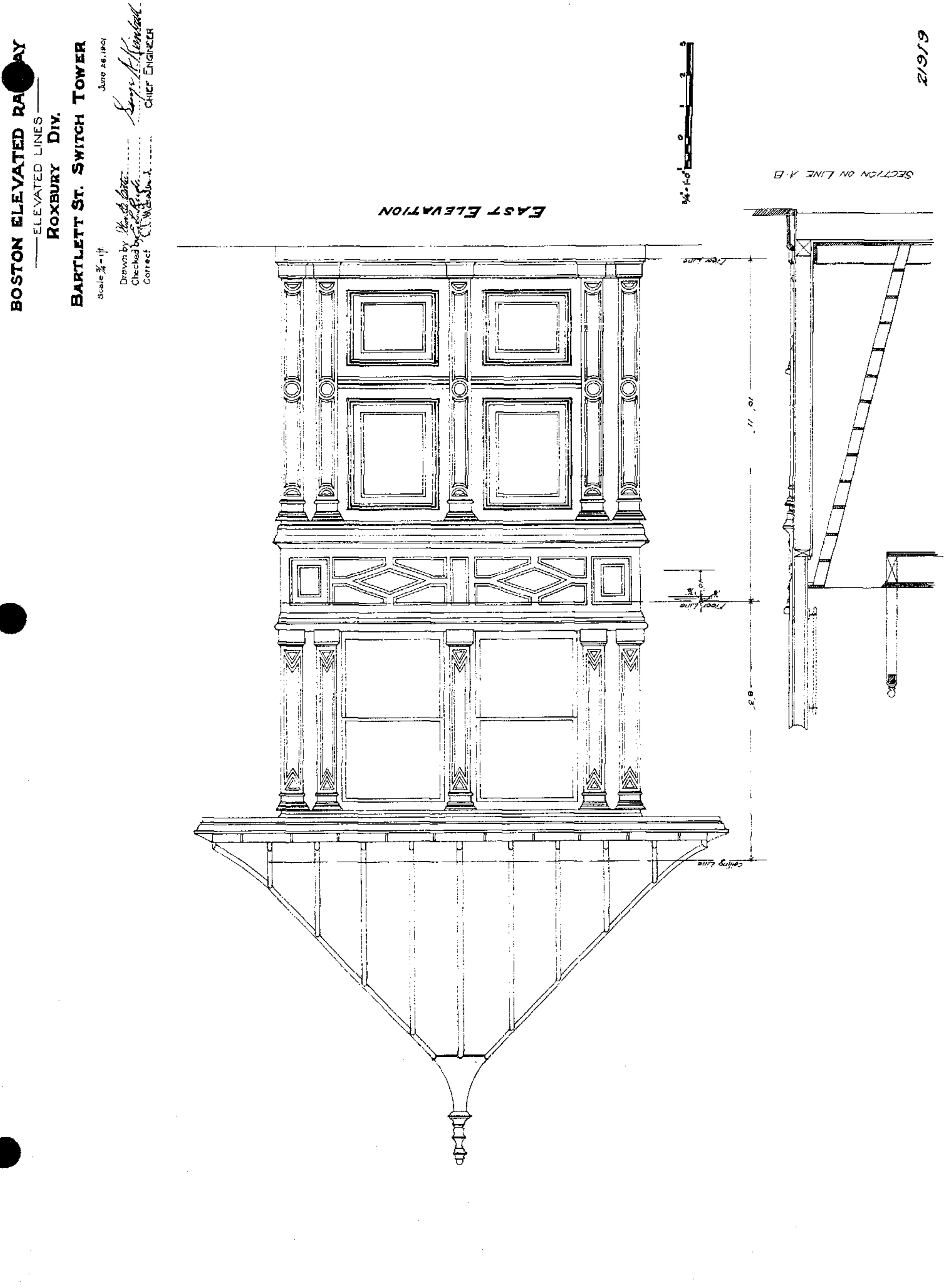
North Elevation & Longitudinal Section of North Bridge

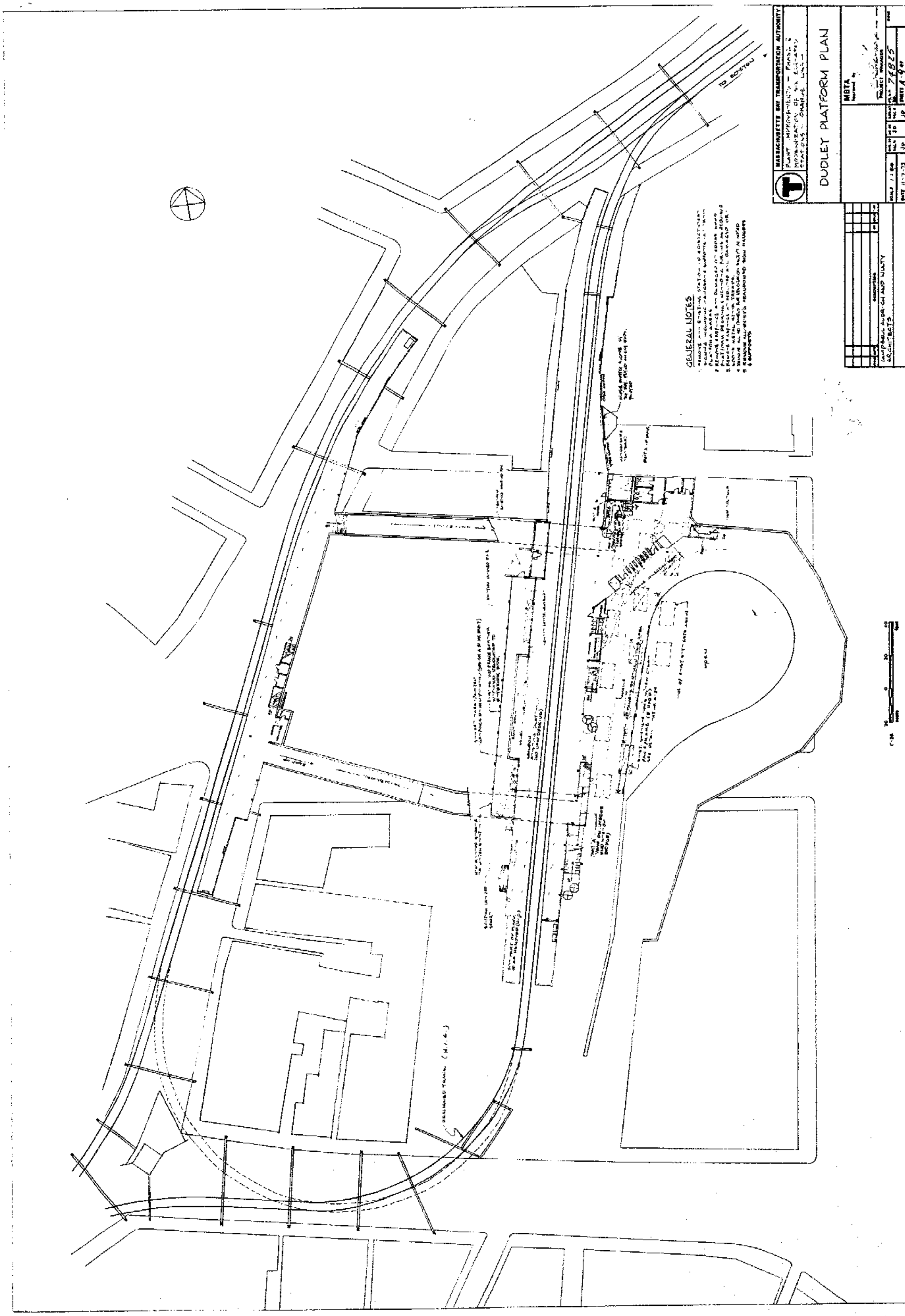
South Elevation of South Bridge

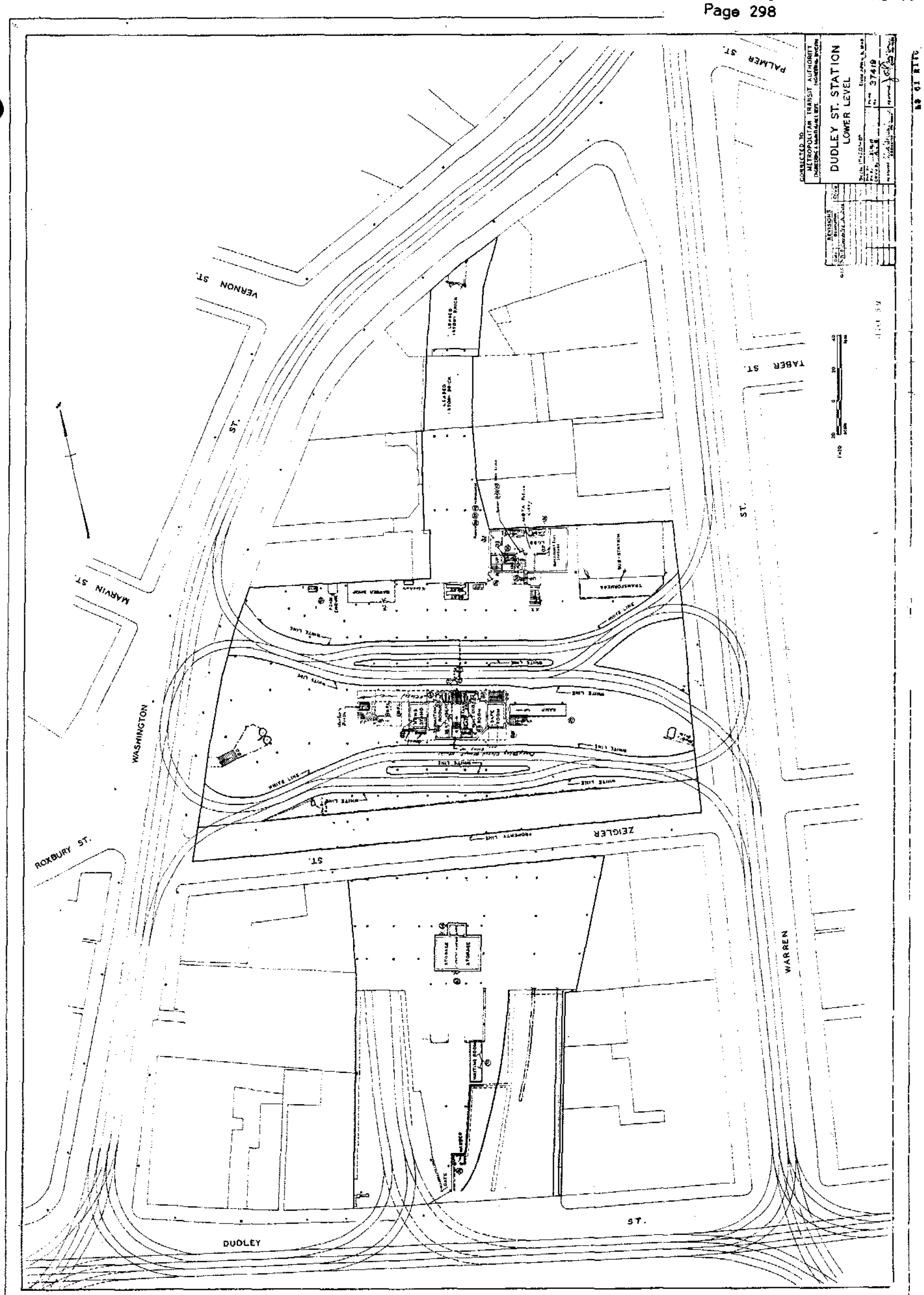

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
DUDLEY ST. STATION
ELEVATED LEVEL
PLAN SHOWING PROPOSED CHANGES
Scale 20 Ft. = 1 In.
August 1909
M7
VERNON ST.
WASHINGTON ST.
MARVIN ST.
ROXBURY ST.
WARREN ST.
ZEIGLER ST.
TABER ST.
DUDLEY ST.
DANA ST.
NORTH BRIDGE
SOUTH BRIDGE
John P. Robinson Heirs
Frank Ferdinand
Frank Ferdinand
Edwin U. Curtis et al.
Harlan P. Whitcomb
George H Wakeman et al.
Institution for Savings in Roxbury & Vicinity
Mary E. Mulvey et al.
George K. Talbot & Charles H. Olmstead
A.T. Worthington et al. Trustees
Chas. D. Swain Heirs
Peoples National Bank
George G Kennedy
A.T. Worthington et al. Trs.
William Sheafe et al. Trs.
Waiting Room
Waiting Room
Loading Platform for Surface Cars
Loading Platform for Surface Cars
Unloading Platform - Elevated Trains
Unloading Platform - Surface Cars
Loading Platform - Elevated Trains
North Bound Elevated Track
Loading Platform - Elevated Trains
Unloading Platform - Surface Cars

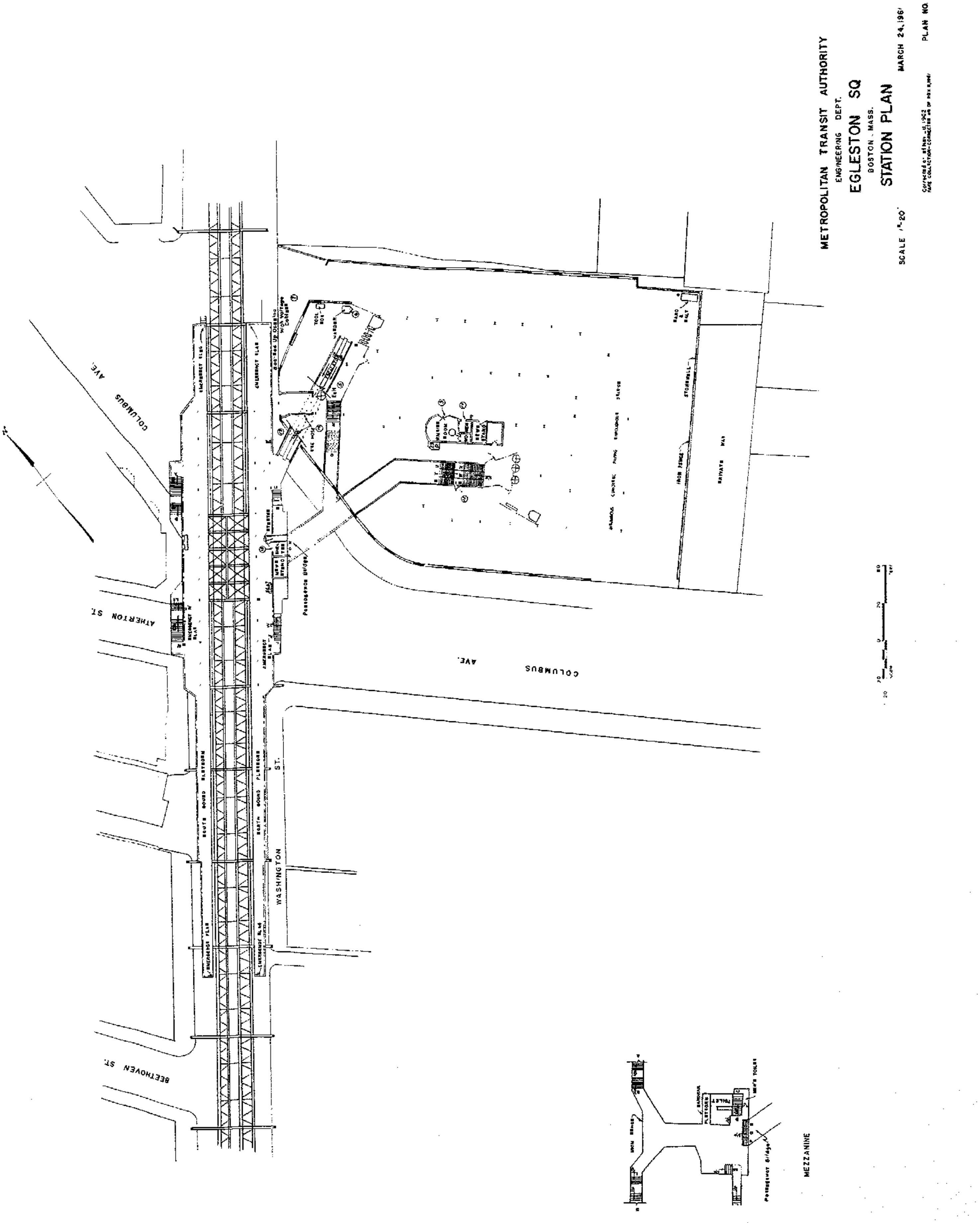

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
DUDLEY ST. STATION
SURFACE LEVEL
August 1911
VERNON ST.
MARVIN ST.
WASHINGTON ST.
ROXBURY ST.
PALMER ST.
TABER ST.
WARREN ST.
ZEIGLER ST.
DUDLEY ST.
DANA ST.
Frank Ferdinand
Edwin U. Curtis et al.
George H. Waterman et al.
Institution for Savings in Roxbury & Vicinity
George N. Talbot & Charles H. Olmsted
A.T. Worthington et al. Trs.
William Skeele et al. Trs.

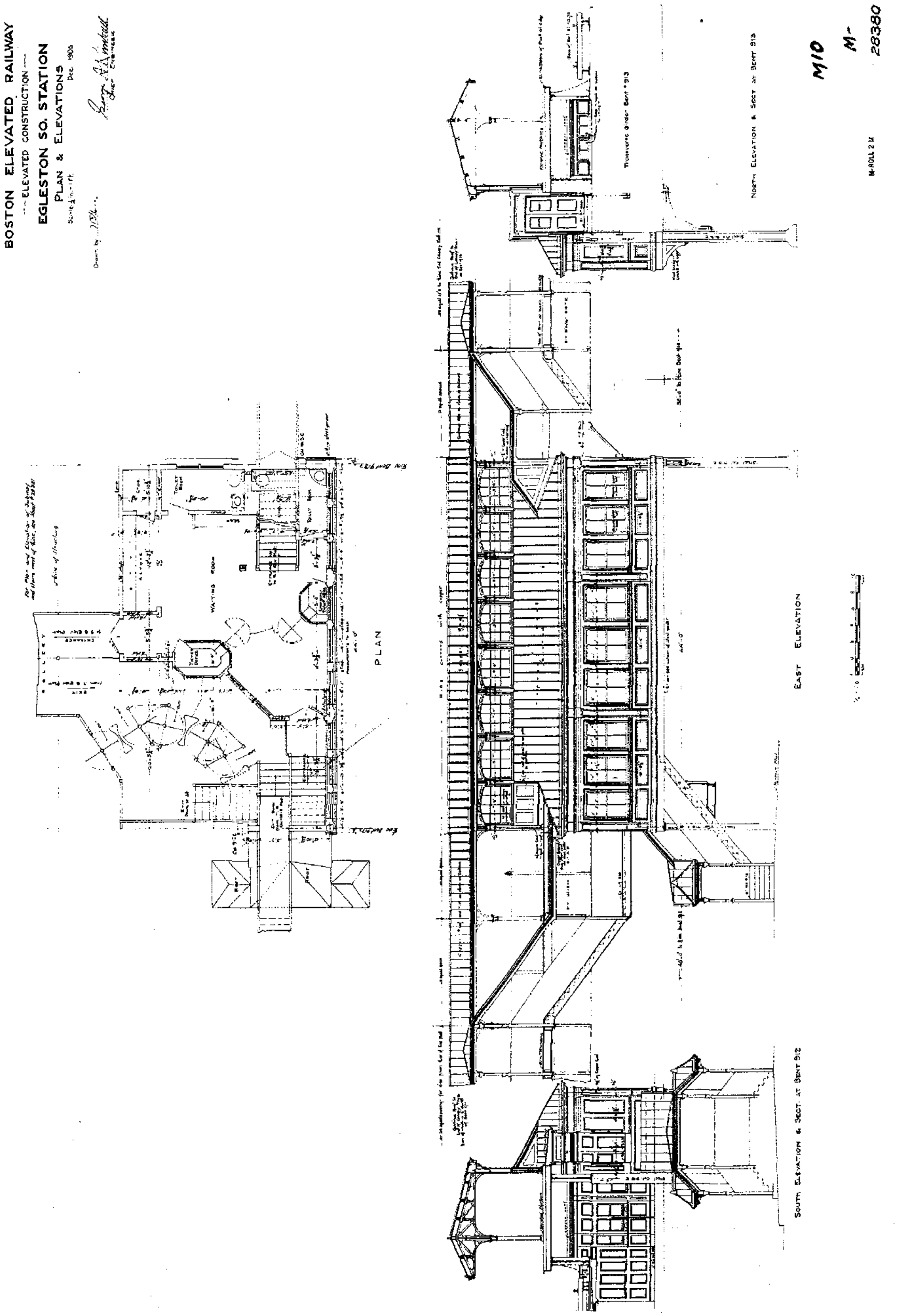

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
DUDLEY ST. STATION
ELEVATED LEVEL
August 1911
VERNON ST.
MARVIN ST.
WASHINGTON ST.
ROXBURY ST.
WARREN ST.
TABER ST.
ZEIGLER
DUDLEY ST.
DANA ST.
Frank Ferdinand
Edwin U. Curtis et al.
George H. Waterman et al.
Harlan P. Whitcomb
Institution for Savings in Roxbury & Vicinity
George N. Talbot & Charles H. Olmsted
A.T. Workington et al. Trs.
William Shrafs et al. Trs.
27589
M7

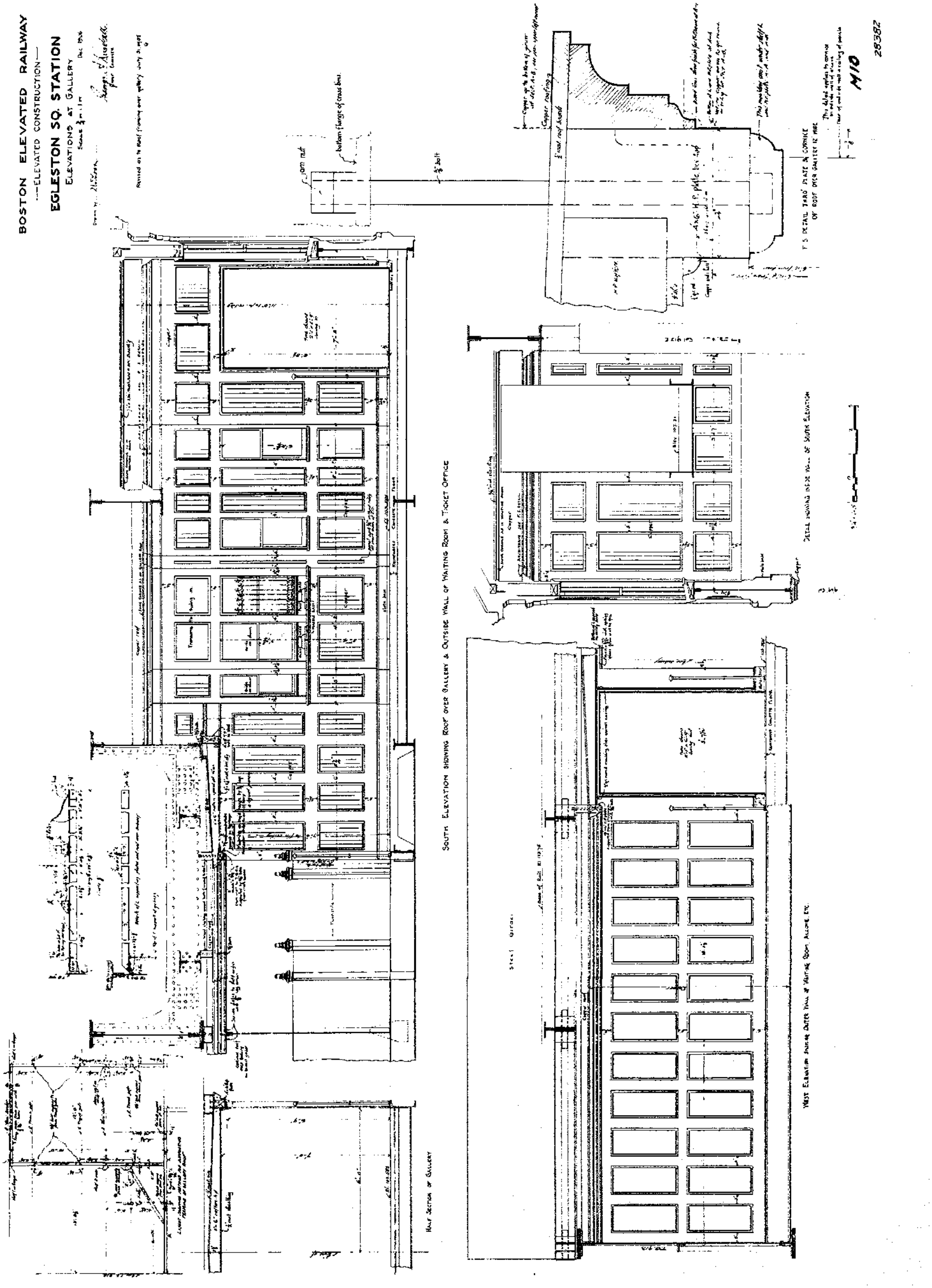

BOSTON ELEVATED RA AY
ELEVATED LINES
ROXBURY DIV.
BARTLETT ST. SWITCH TOWER
June 26, 1901
Scale 3/4-1ft
Drawn by
Checked by
Correct
CHIEF ENGINEER
EAST ELEVATION
SECTION ON LINE A-B
Floor Line
Floor Line
Ceiling Line
21919

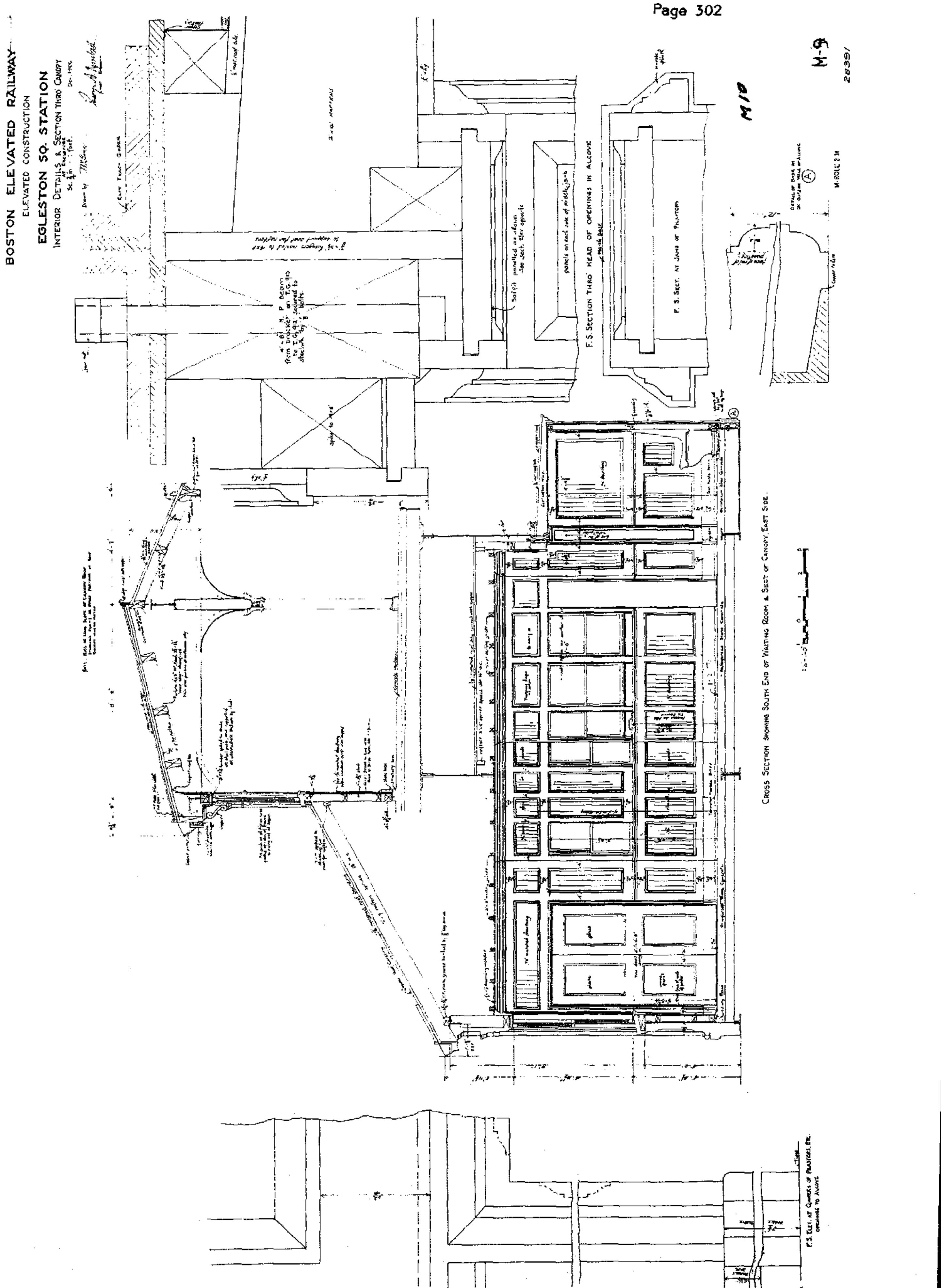

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY
DUDLEY PLATFORM PLAN
MBTA
GENERAL NOTES
TO BOSTON

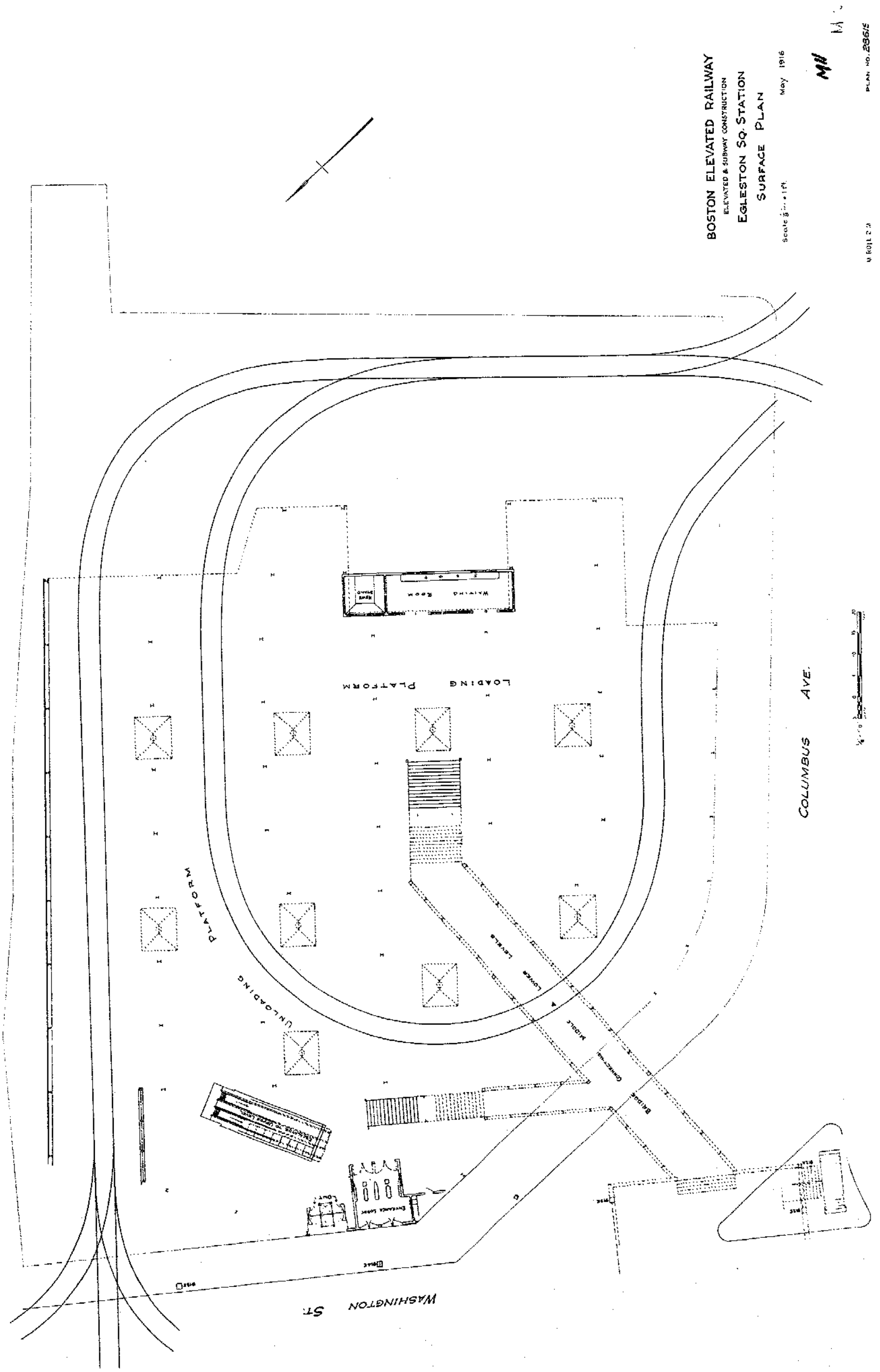

CORRECTED TO
METROPOLITAN TRANSIT AUTHORITY
DUDLEY ST. STATION
LOWER LEVEL
37419
REVISIONS
PALMER ST.
VERNON ST.
TABER ST.
MARVIN ST.
ST.
WASHINGTON
ROXBURY ST.
ZEIGLER
ST.
WARREN
ST.
DUDLEY
ST.
WHITE LINE
PROPERTY LINE
BARBER SHOP
SUB-STATION
TRANSFORMER
RAMP
SAFE ROOM
STORAGE
STORAGE
WAITING ROOM
GATE

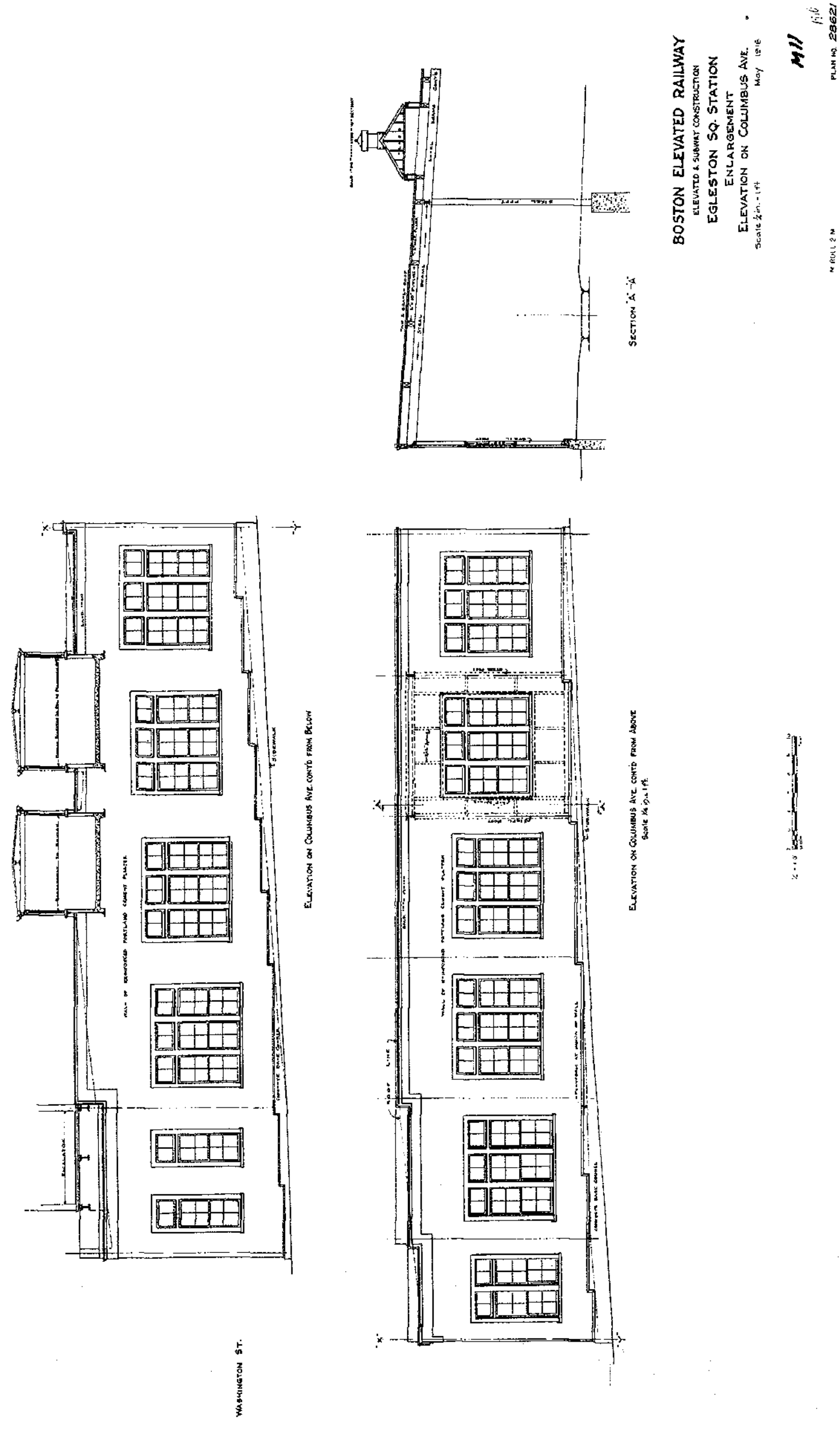

METROPOLITAN TRANSIT AUTHORITY
ENGINEERING DEPT.
EGLESTON SQ
BOSTON, MASS.
STATION PLAN
SCALE 1"=20'
MARCH 24, 1961
PLAN NO. 37417-1
COLUMBUS AVE.
ATHERTON ST.
WASHINGTON ST.
BEETHOVEN ST.
SOUTH BOUND PLATFORM
NORTH BOUND PLATFORM
EMERGENCY STAIR
PRIVATE WAY
STONEWALL
IRON FENCE
Passenger Bridge
MEZZANINE

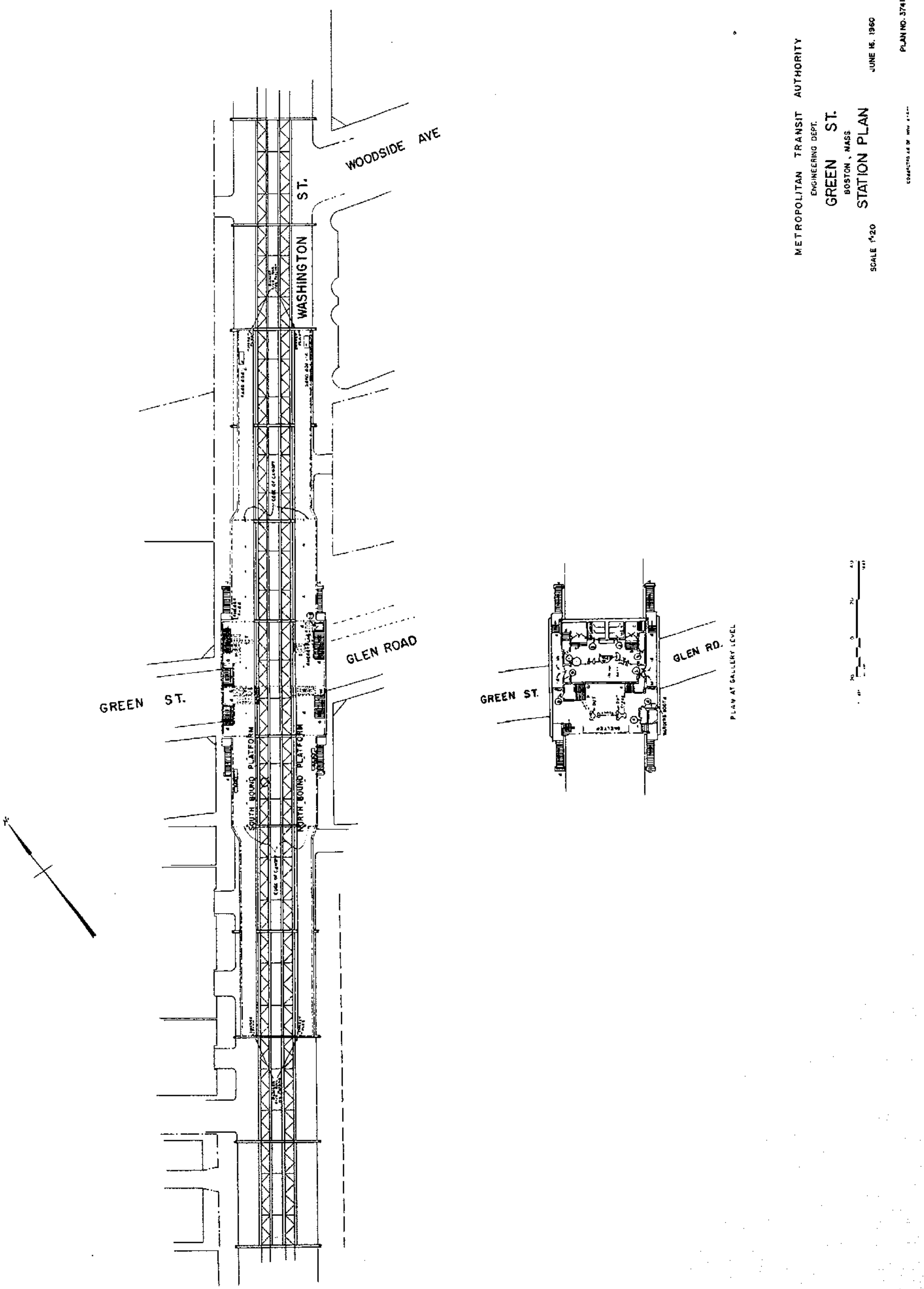

BOSTON ELEVATED RAILWAY
— ELEVATED CONSTRUCTION —
EGLESTON SO. STATION
PLAN & ELEVATIONS
Dec. 1906
PLAN
WAITING ROOM
EAST ELEVATION
NORTH ELEVATION & SECT. AT BENT 913
SOUTH ELEVATION & SECT. AT BENT 912
M10
M-28380

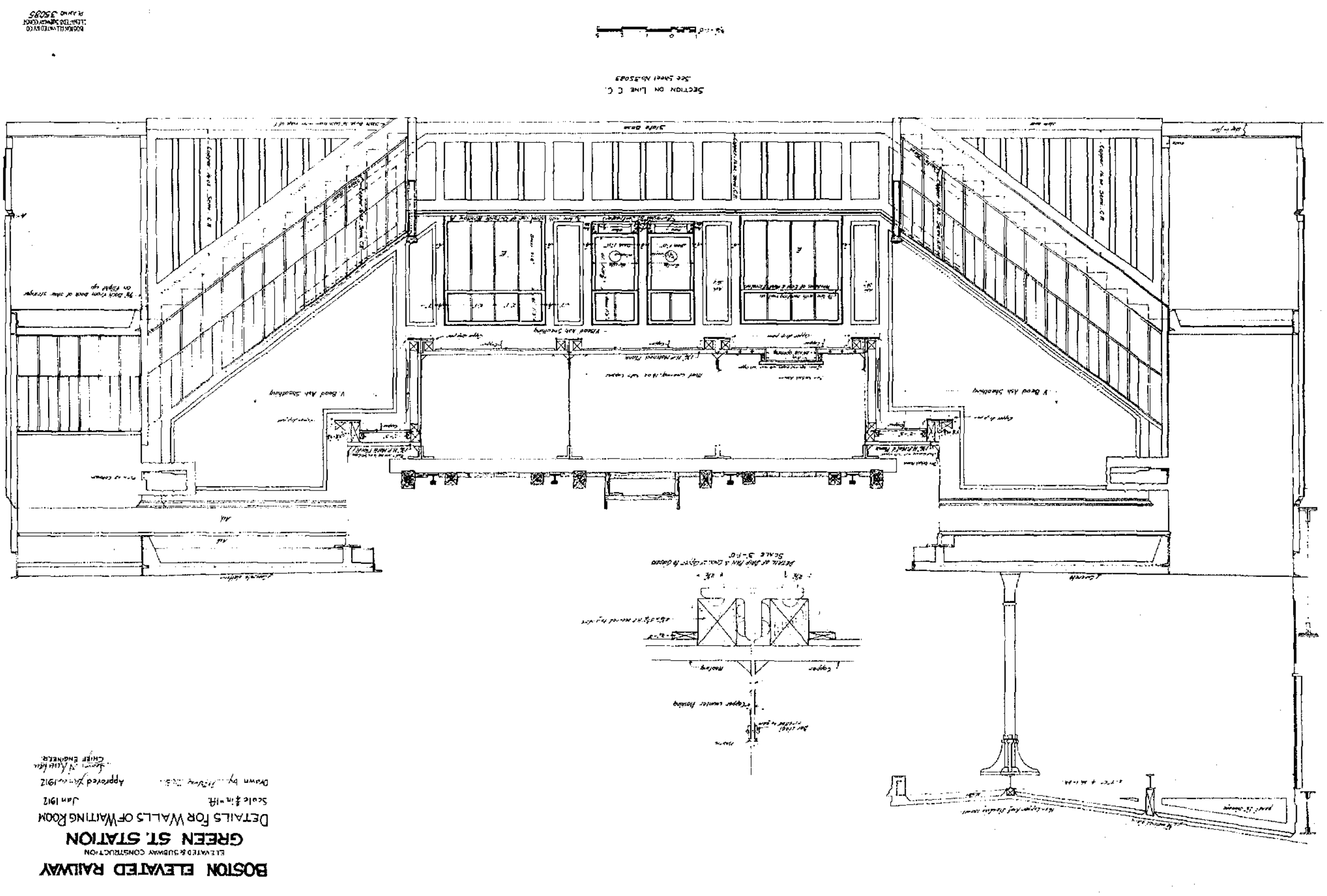

BOSTON ELEVATED RAILWAY
—ELEVATED CONSTRUCTION—
EGLESTON SQ. STATION
ELEVATIONS AT GALLERY
SOUTH ELEVATION SHOWING ROOF OVER GALLERY & OUTSIDE WALL OF WAITING ROOM & TICKET OFFICE
WEST ELEVATION SHOWING OUTER WALL OF WAITING ROOM, ALCOVE ETC.
HALF SECTION OF GALLERY
DETAIL SHOWING INSIDE WALL OF SOUTH ELEVATION
M10
28382

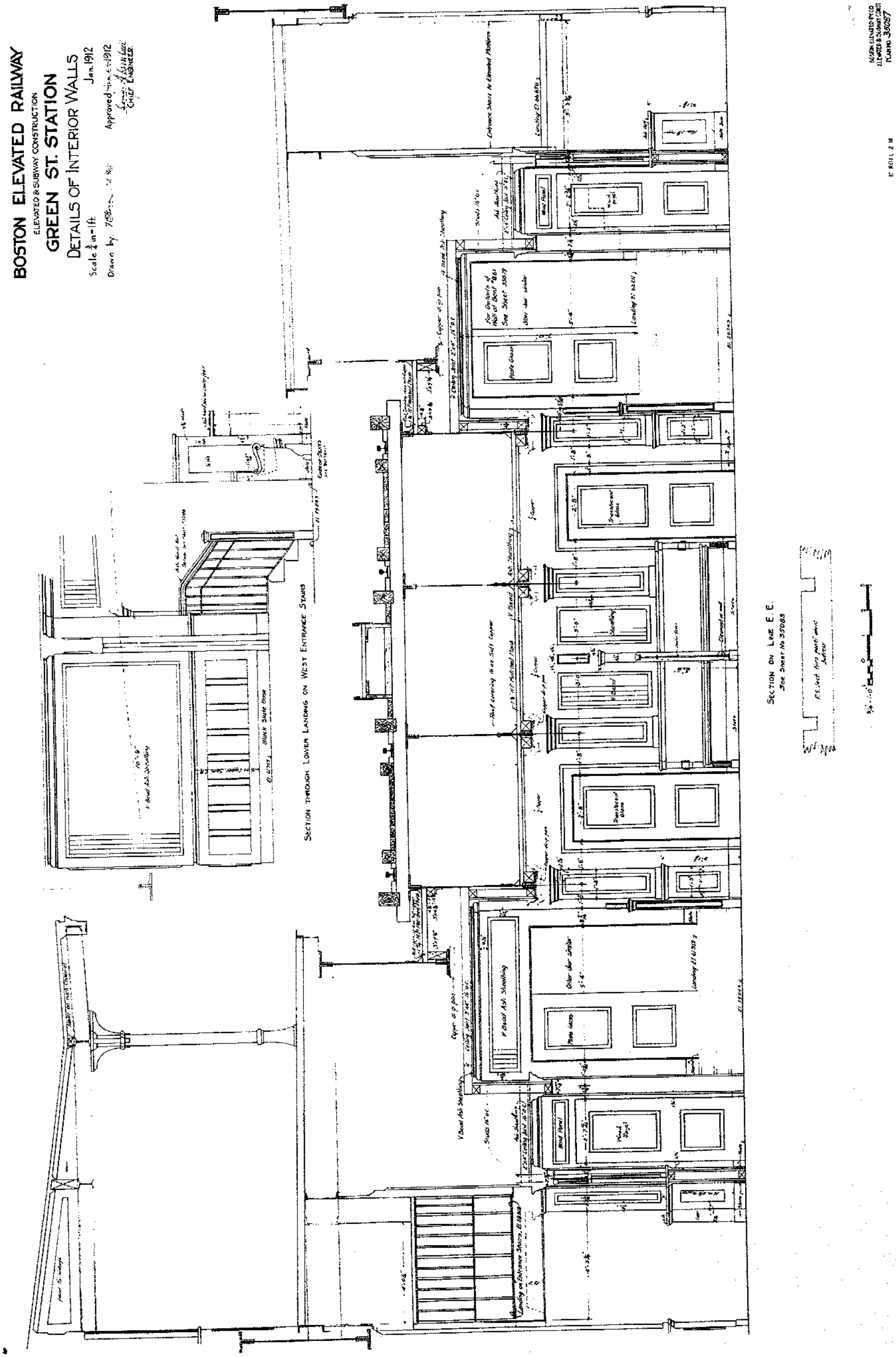

BOSTON ELEVATED RAILWAY
ELEVATED CONSTRUCTION
EGLESTON SQ. STATION
INTERIOR DETAILS & SECTION THRO' CANOPY
F.S. SECTION THRO' HEAD OF OPENINGS IN ALCOVE
F. S. SECT. AT JAMB OF PILASTERS
CROSS SECTION SHOWING SOUTH END OF WAITING ROOM & SECT OF CANOPY, EAST SIDE.
F.S. ELEV. AT CORNERS OF PILASTERS, ETC. OPENINGS TO ALCOVE
M-9
M-10
28391

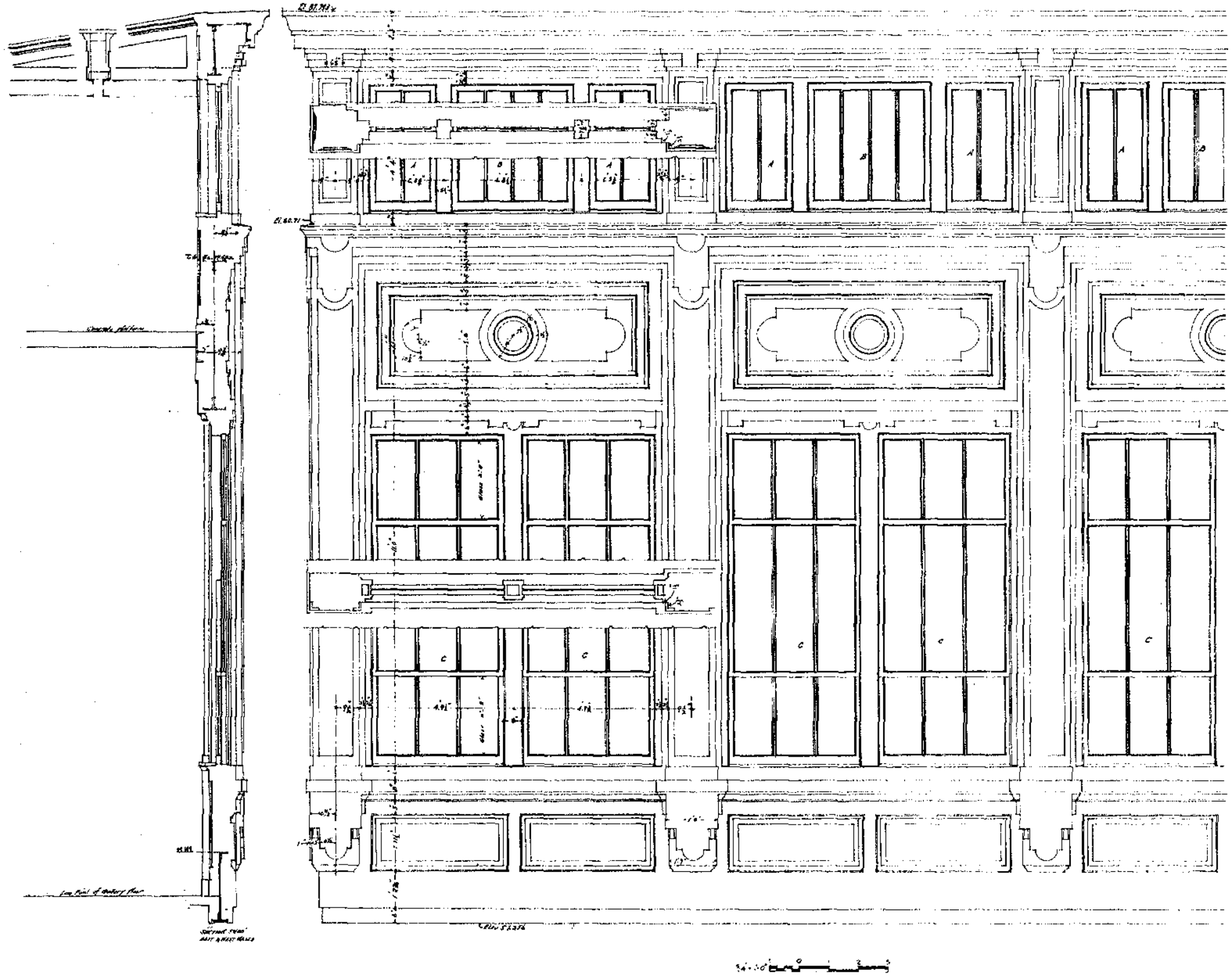

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
EGLESTON SQ. STATION
SURFACE PLAN
May 1916
LOADING PLATFORM
WAITING ROOM
UNLOADING PLATFORM
COLUMBUS AVE.
WASHINGTON ST.


BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
EGLESTON SQ. STATION
ENLARGEMENT
ELEVATION ON COLUMBUS AVE.
Scale 1/4 in. = 1 ft.
May 1916
M11
PLAN NO. 28621
SECTION 'A'-'A'
ELEVATION ON COLUMBUS AVE. CONT'D FROM BELOW
ELEVATION ON COLUMBUS AVE. CONT'D FROM ABOVE
Scale 1/4 in. = 1 ft.
SIDEWALK
ROOF LINE
WASHINGTON ST.


METROPOLITAN TRANSIT AUTHORITY
ENGINEERING DEPT.
GREEN ST.
BOSTON, MASS
STATION PLAN
SCALE 1"=20'
JUNE 16, 1960
PLAN NO. 37416
WOODSIDE AVE
WASHINGTON ST.
GLEN ROAD
GREEN ST.
SOUTH BOUND PLATFORM
NORTH BOUND PLATFORM
GREEN ST.
GLEN RD.
PLAN AT GALLERY LEVEL


BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
GREEN ST. STATION
DETAILS FOR WALLS OF WAITING ROOM
Jan 1912
Section on Line C C.
See Sheet No. 35083
V. Bead Ash Sheathing
Slate Base
CHIEF ENGINEER


BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
GREEN ST. STATION
DETAILS OF INTERIOR WALLS
Jan. 1912
CHIEF ENGINEER
SECTION THROUGH LOWER LANDING ON WEST ENTRANCE STAIRS
SECTION ON LINE E.E.

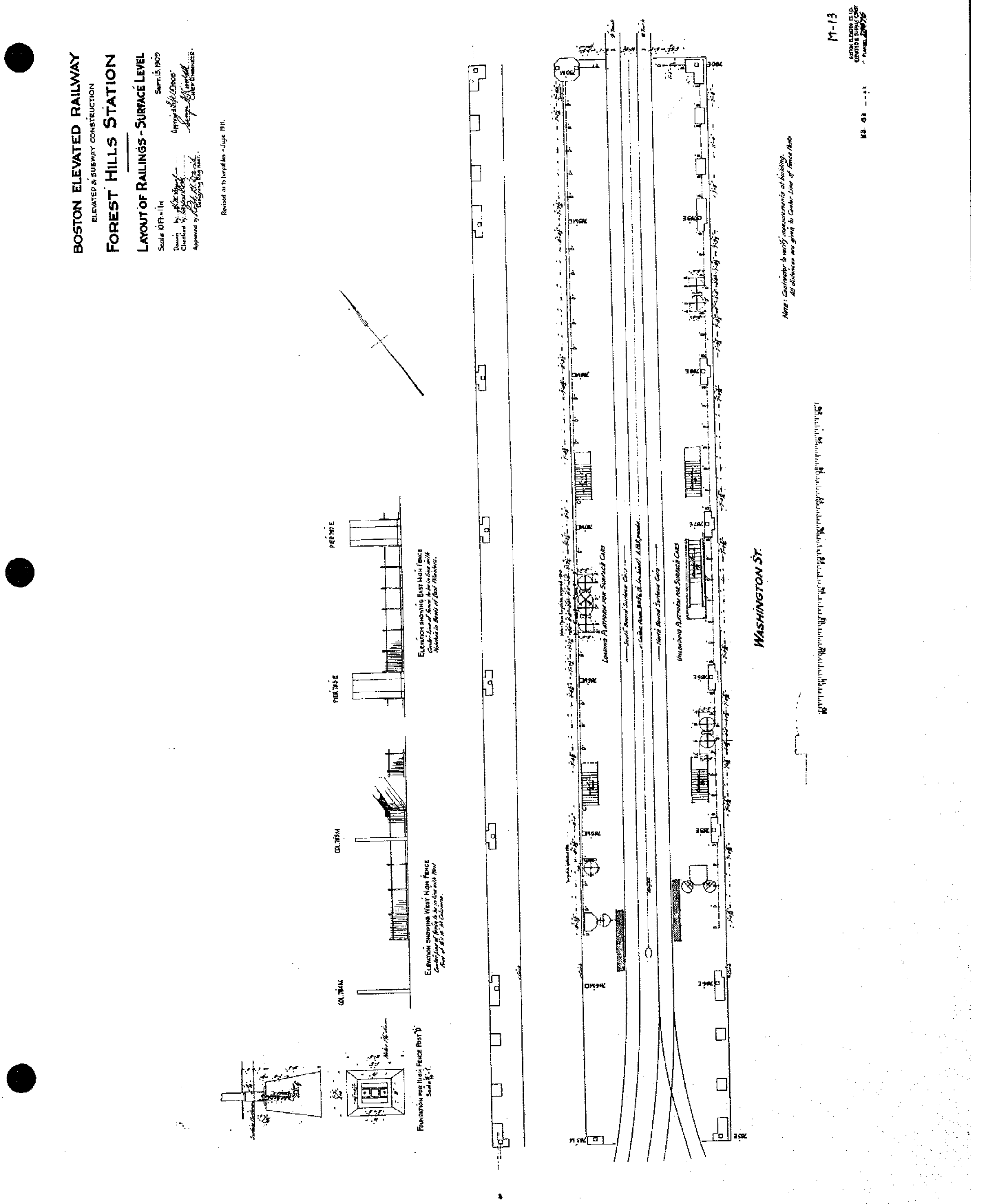


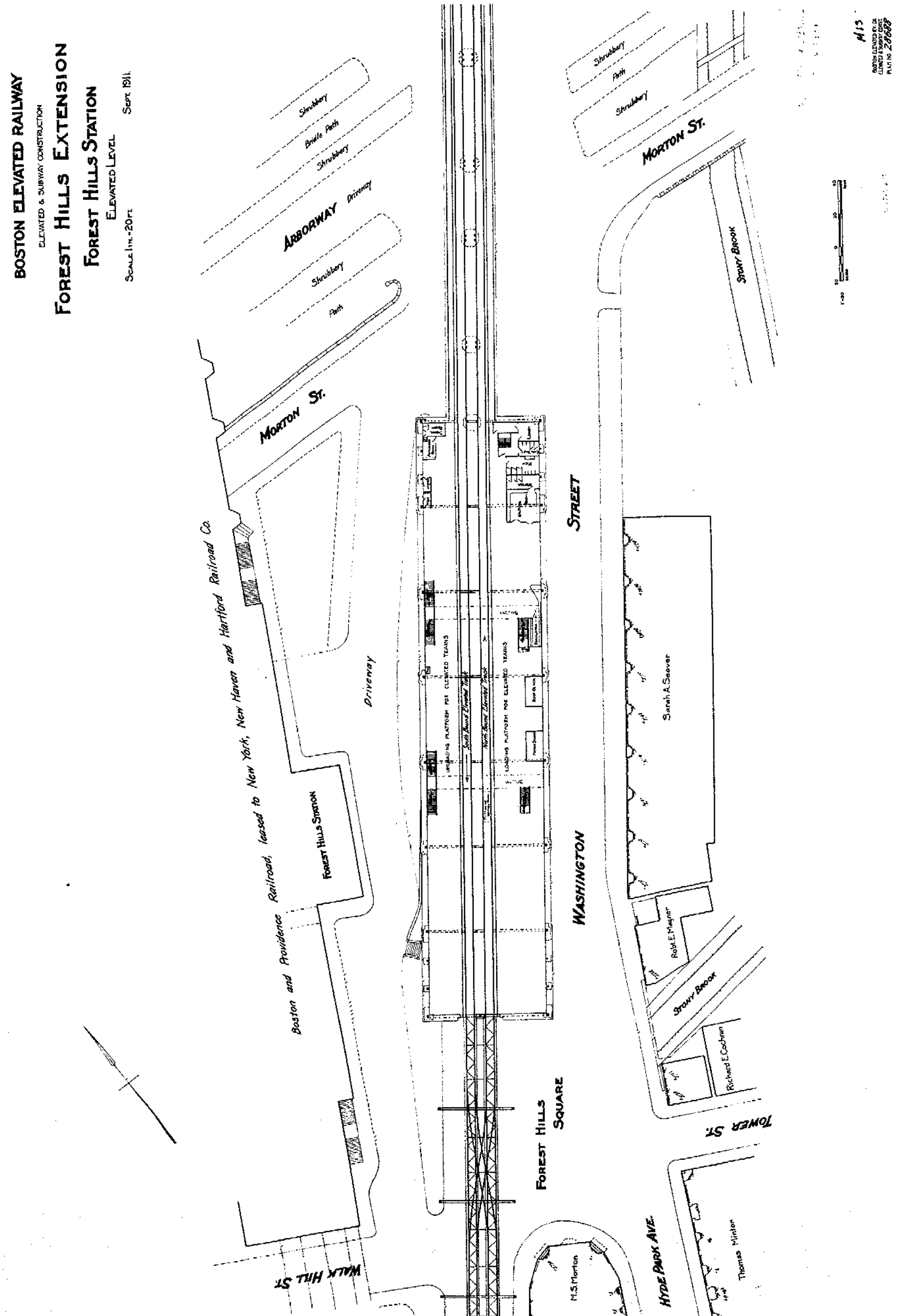
BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
GREEN ST. STATION
DETAILS OF ELEVATION AND SECTION
Scale 3/4 in = 1 ft. Jan 1912
Drawn by ... Approved June 2 1912
Chief Engineer

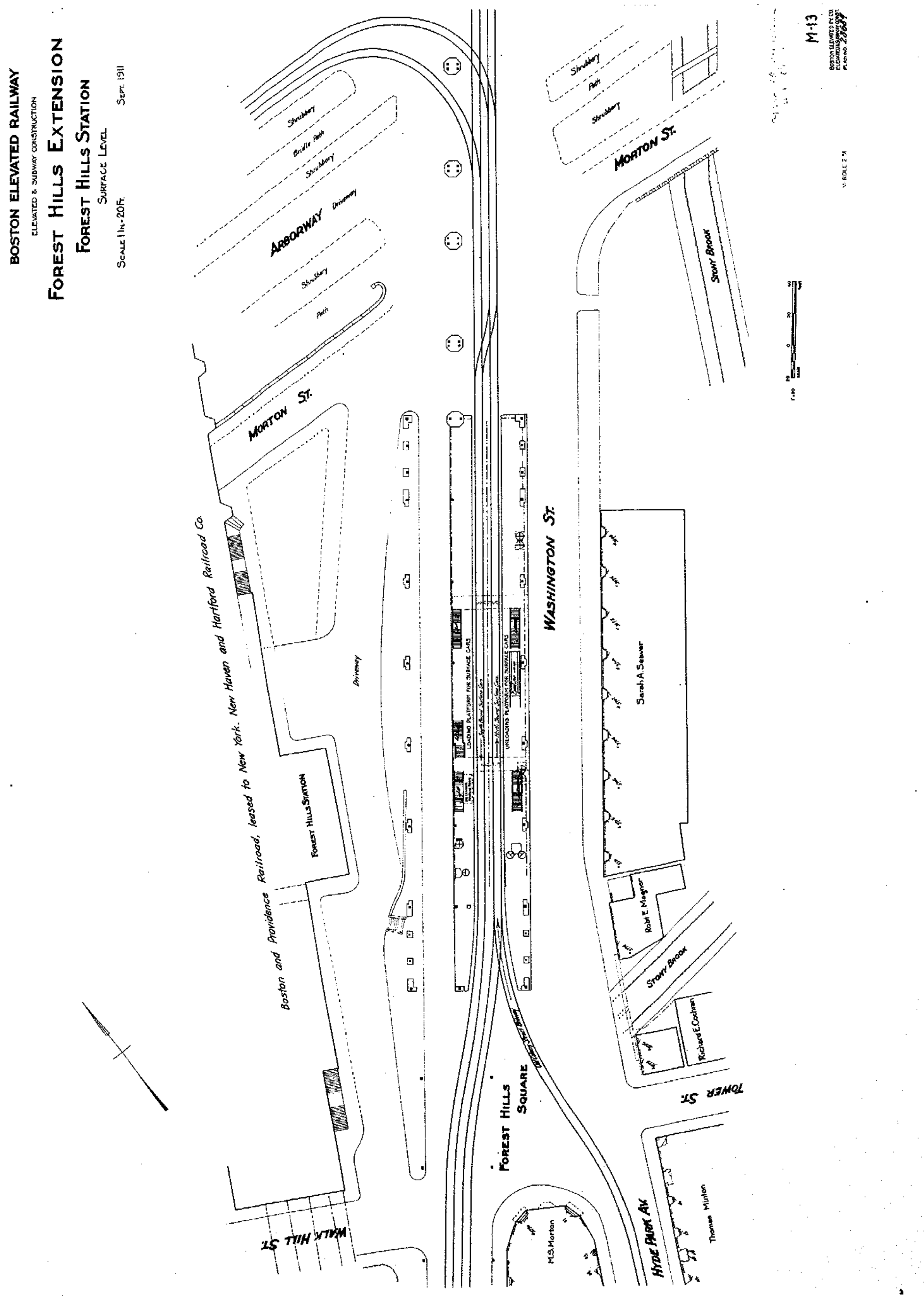
M 17

M ROLL 2 M

BOSTON ELEVATED RY. CO.
ELEVATED & SUBWAY CONST.
PLAN No. 35089


BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS STATION
LAYOUT OF RAILINGS - SURFACE LEVEL
Revised as to turnstiles - June 1911.
WASHINGTON ST.
LOADING PLATFORM FOR SURFACE CARS
UNLOADING PLATFORM FOR SURFACE CARS
ELEVATION SHOWING EAST HIGH FENCE
ELEVATION SHOWING WEST HIGH FENCE
FOUNDATION FOR HIGH FENCE POST "D"
M-13


BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS EXTENSION
FOREST HILLS STATION
ELEVATED LEVEL
SCALE 1 IN. = 20 FT.
SEPT. 1911.
Shrubbery
Bridle Path
Shrubbery
ARBORWAY
Driveway
Shrubbery
Path
MORTON ST.
Shrubbery
Path
Shrubbery
MORTON ST.
STONY BROOK
Boston and Providence Railroad, leased to New York, New Haven and Hartford Railroad Co.
Driveway
FOREST HILLS STATION
UNLOADING PLATFORM FOR ELEVATED TRAINS
South Bound Elevated Track
North Bound Elevated Track
LOADING PLATFORM FOR ELEVATED TRAINS
STREET
WASHINGTON
Sarah A. Seaver
Robt. E. Magner
STONY BROOK
Richard E. Cochran
TOWER ST.
FOREST HILLS SQUARE
WALK HILL ST.
M. S. Morton
HYDE PARK AVE.
Thomas Minton


BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS EXTENSION
FOREST HILLS STATION
SURFACE LEVEL
SCALE 1 In.=20 Ft.
SEPT. 1911
M-13
MORTON ST.
ARBORWAY
Driveway
Shrubbery
Bridle Path
Path
MORTON ST.
WASHINGTON ST.
STONY BROOK
Sarah A. Seaver
Robt E. Magner
Richard E. Cochran
TOWER ST.
HYDE PARK AV.
Thomas Minton
M.S. Morton
FOREST HILLS SQUARE
WALK HILL ST.
FOREST HILLS STATION
Driveway
Boston and Providence Railroad, leased to New York, New Haven and Hartford Railroad Co.
LOADING PLATFORM FOR SURFACE CARS
UNLOADING PLATFORM FOR SURFACE CARS

BOSTON ELEVATED RAILWAY

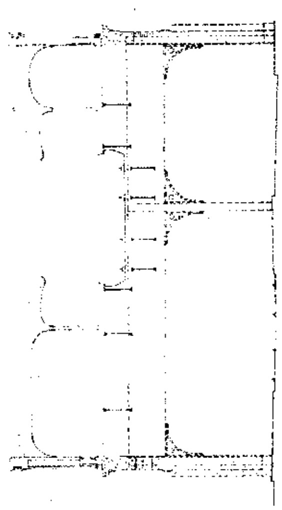
ELEVATED & SUBWAY CONSTRUCTION

FOREST HILLS EXTENSION

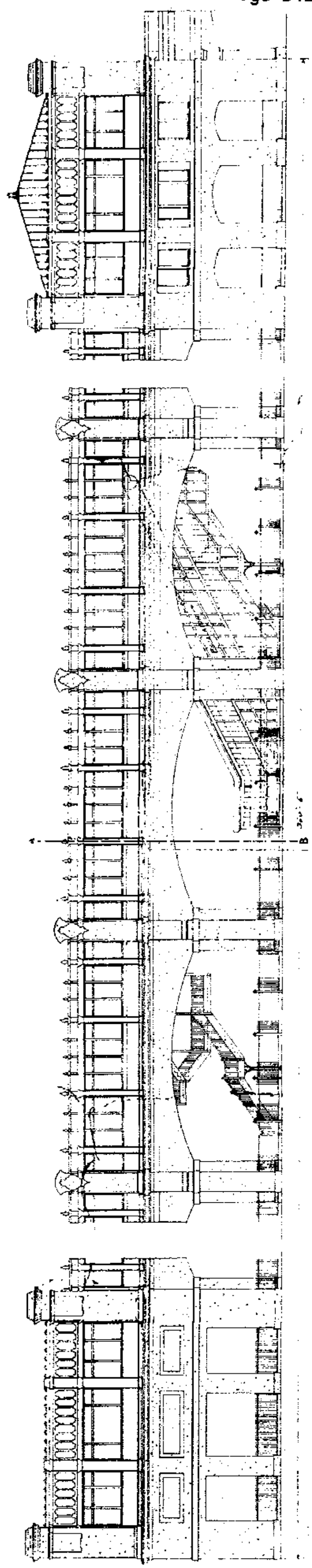
FOREST HILLS STATION

SCALE 1/8 IN = 1 FT

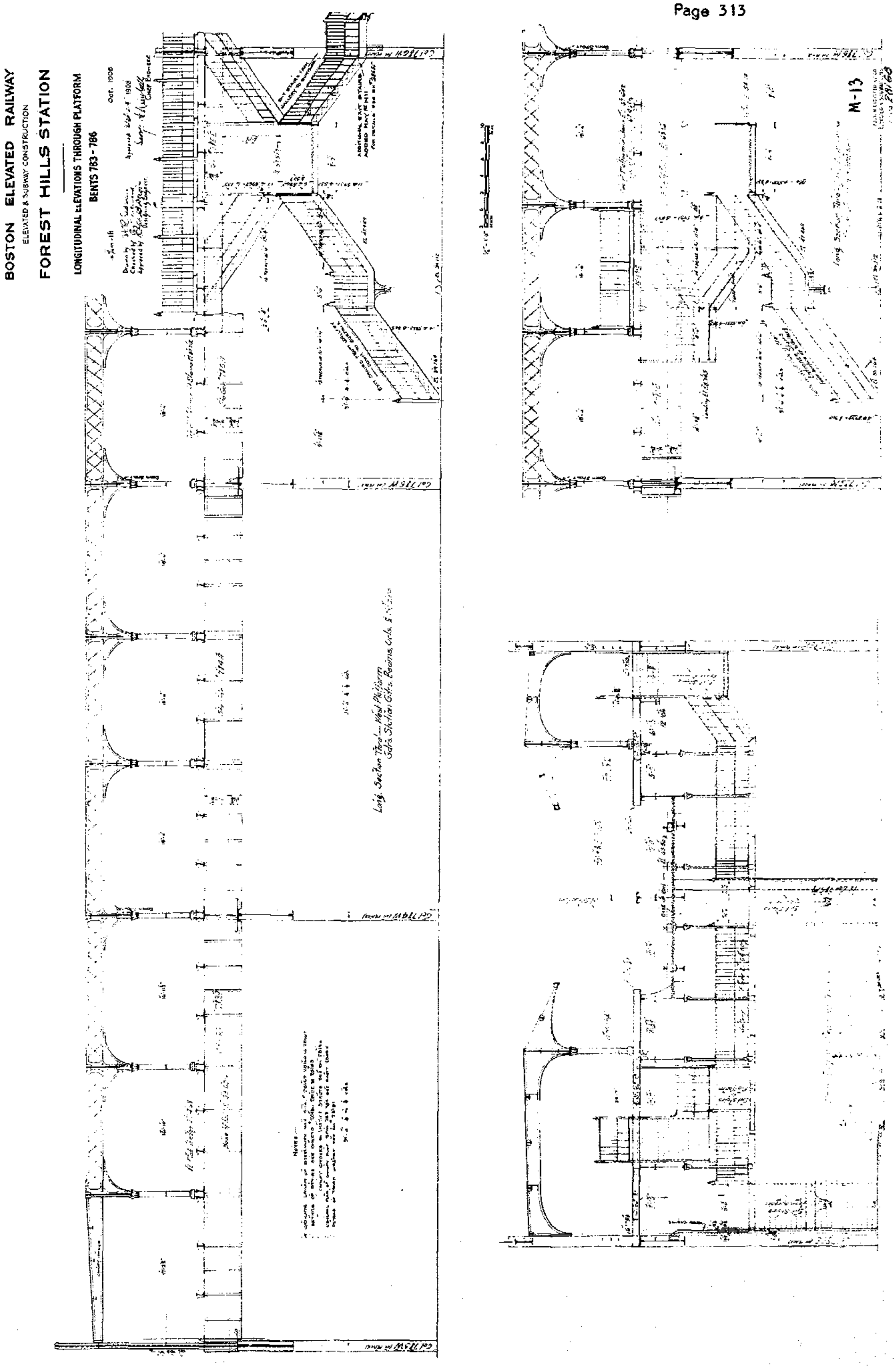
FEB 1909

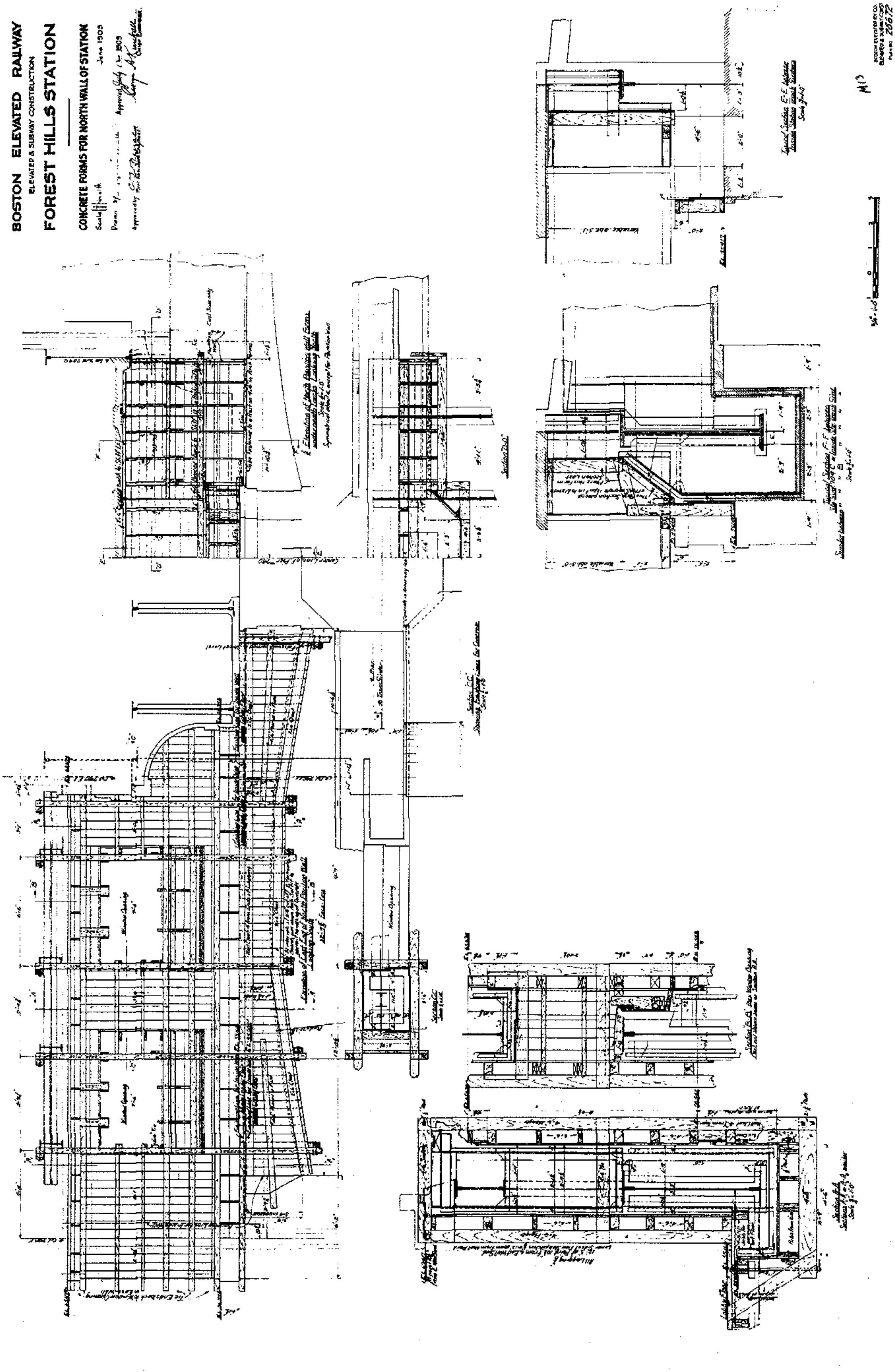


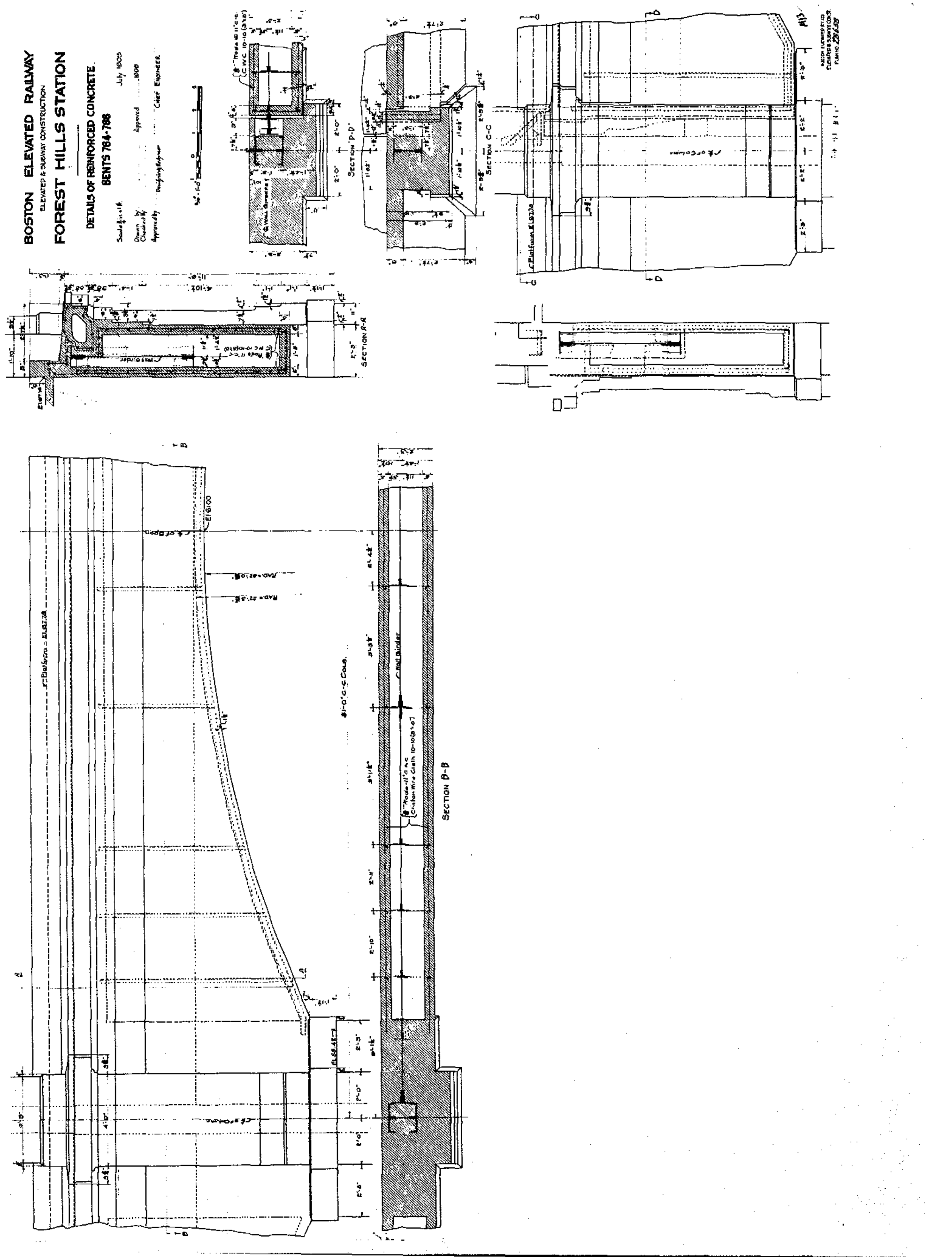
SECTION AT A-B

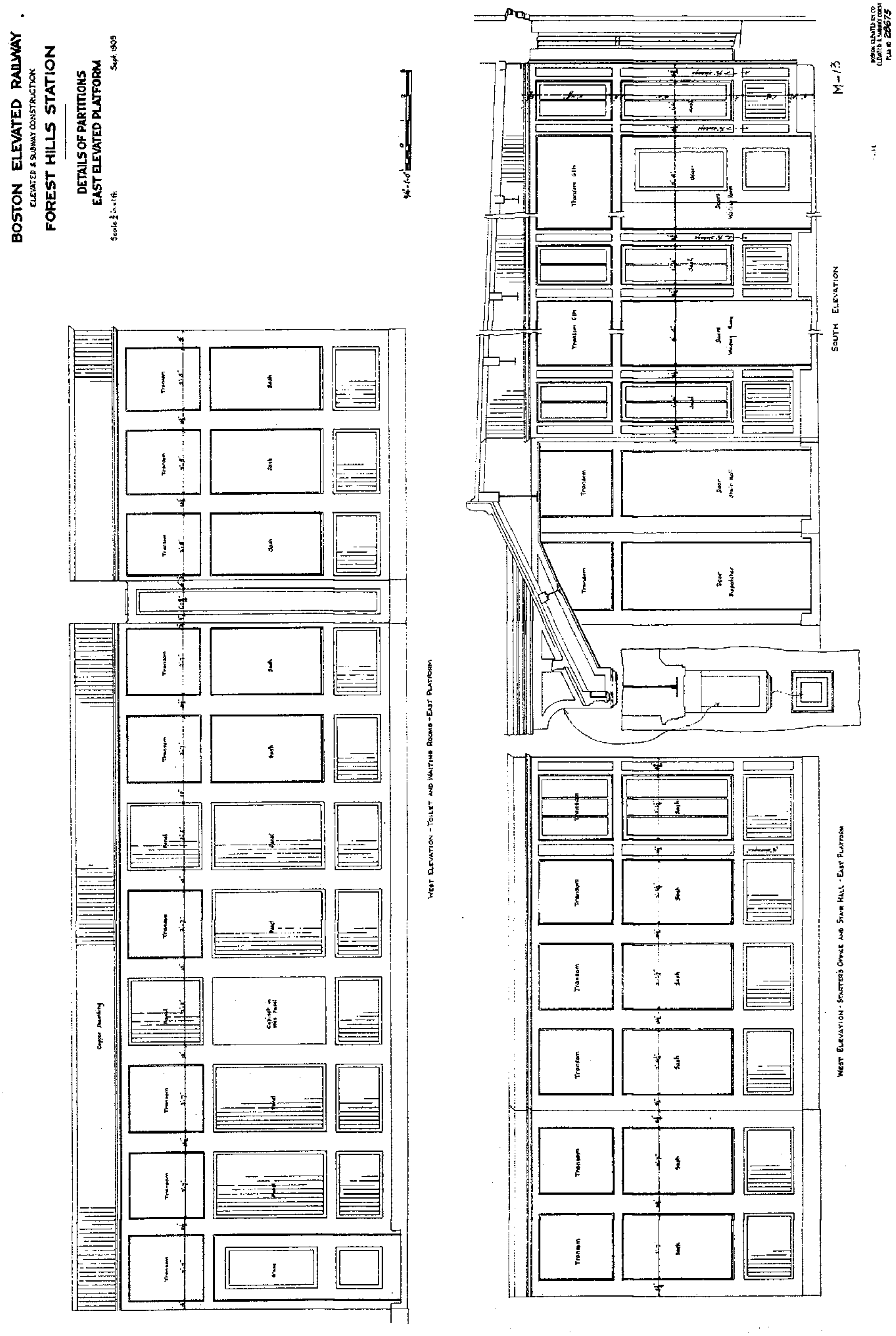


EAST ELEVATION

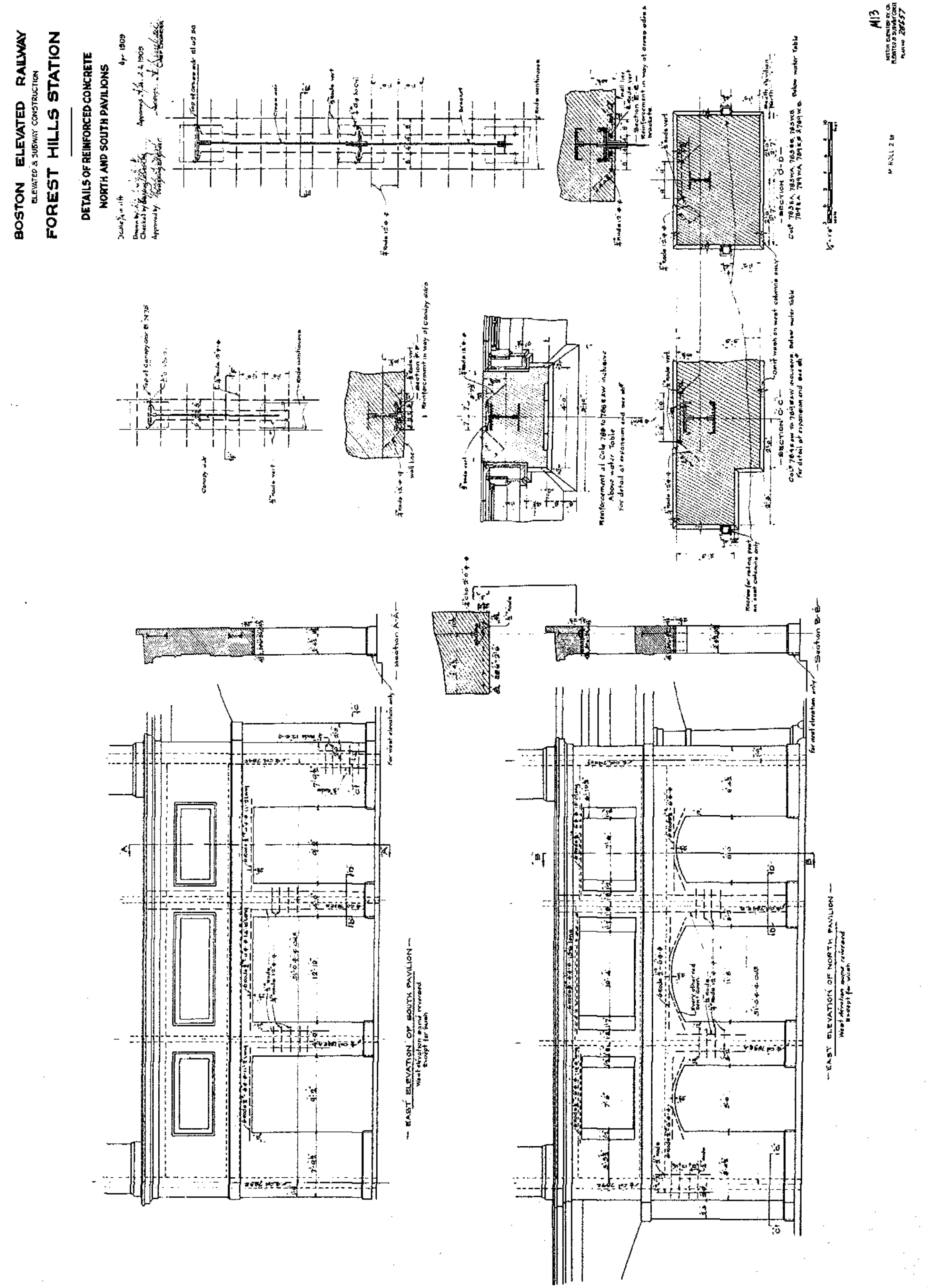

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS STATION
LONGITUDINAL ELEVATIONS THROUGH PLATFORM
BENTS 783-786
Oct. 1908
M-13

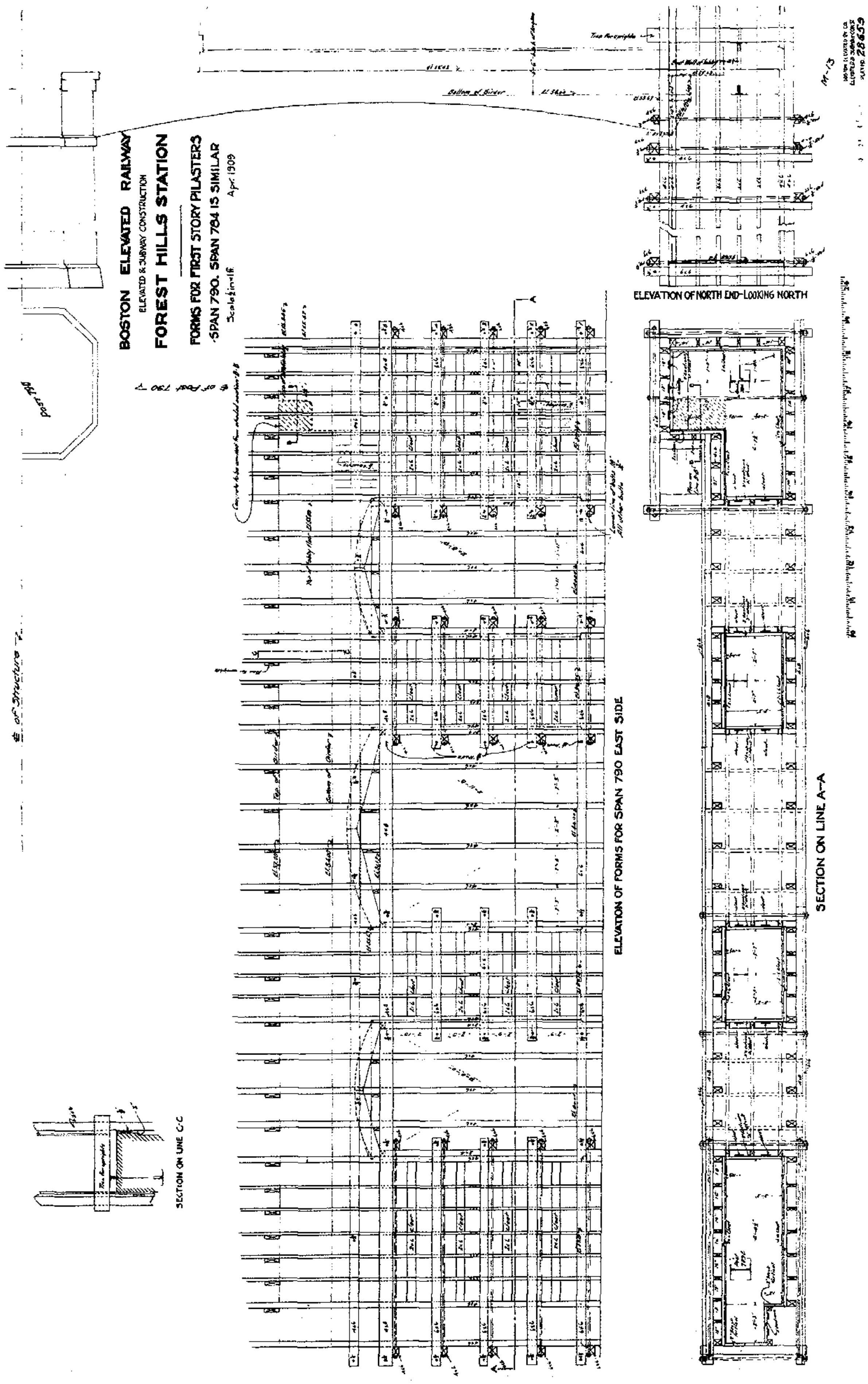

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS STATION
CONCRETE FORMS FOR NORTH WALL OF STATION
June 1909

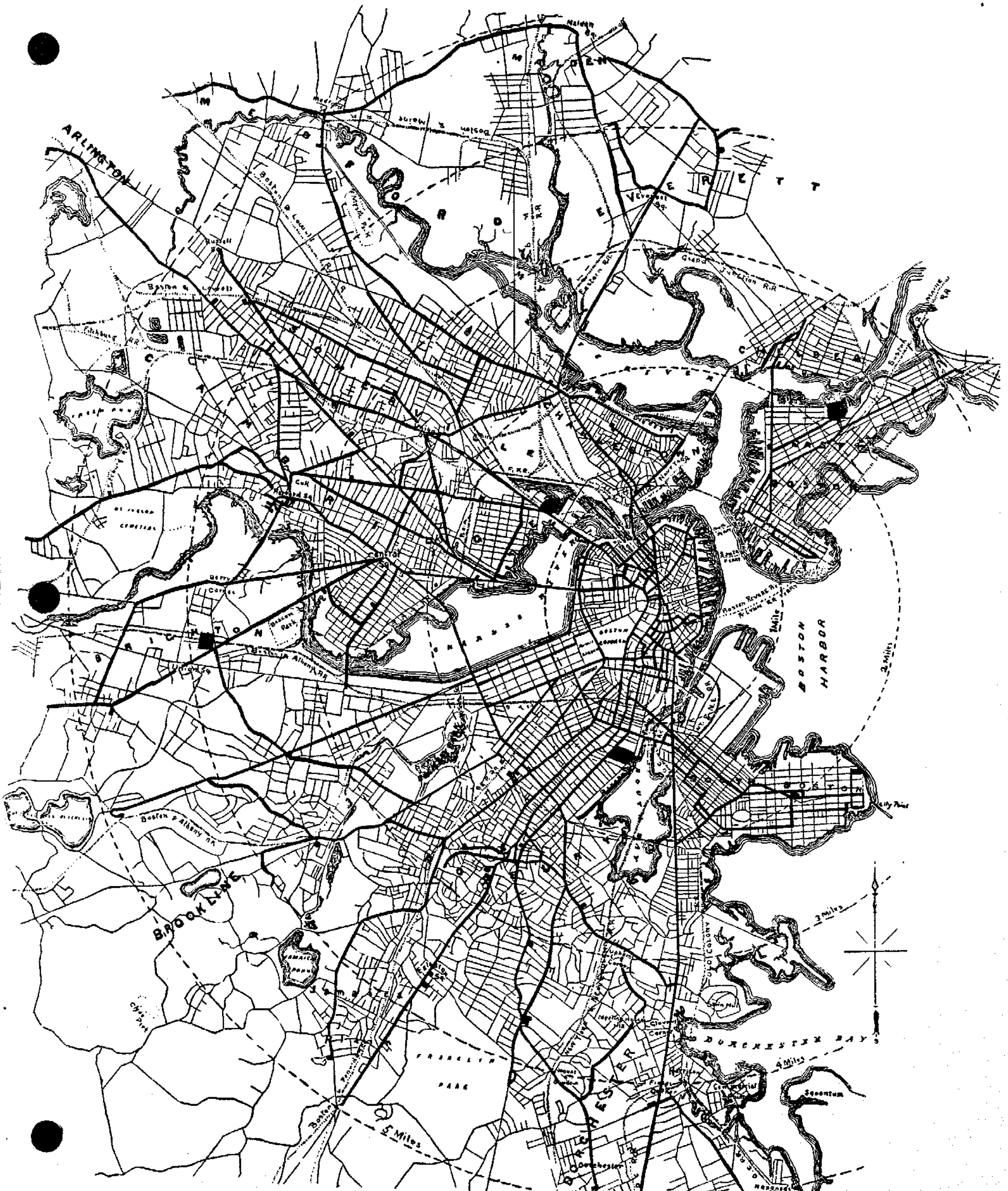

BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS STATION
DETAILS OF REINFORCED CONCRETE
BENTS 784-788
July 1909
Chief Engineer
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D



BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS STATION
DETAILS OF PARTITIONS
EAST ELEVATED PLATFORM
Sept 1909
M-13
SOUTH ELEVATION
WEST ELEVATION - TOILET AND WAITING ROOMS - EAST PLATFORM
WEST ELEVATION - STARTER'S OFFICE AND STAIR HALL - EAST PLATFORM


BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS STATION
DETAILS OF REINFORCED CONCRETE
NORTH AND SOUTH PAVILIONS
— SECTION A-A —
— SECTION B-B —
— SECTION C-C —
— SECTION D-D —
— EAST ELEVATION OF SOUTH PAVILION —
West elevation same reversed except for wash
— EAST ELEVATION OF NORTH PAVILION —
West elevation same reversed except for wash


BOSTON ELEVATED RAILWAY
ELEVATED & SUBWAY CONSTRUCTION
FOREST HILLS STATION
FORMS FOR FIRST STORY PILASTERS
SPAN 790. SPAN 784 IS SIMILAR
Apr. 1909
ELEVATION OF FORMS FOR SPAN 790 EAST SIDE
ELEVATION OF NORTH END-LOOKING NORTH
SECTION ON LINE A-A
SECTION ON LINE C-C
Bottom of Girder
Post 790
28659



MAP OF BOSTON, SHOWING LINES OF THE WEST END STREET RAILWAY CO.